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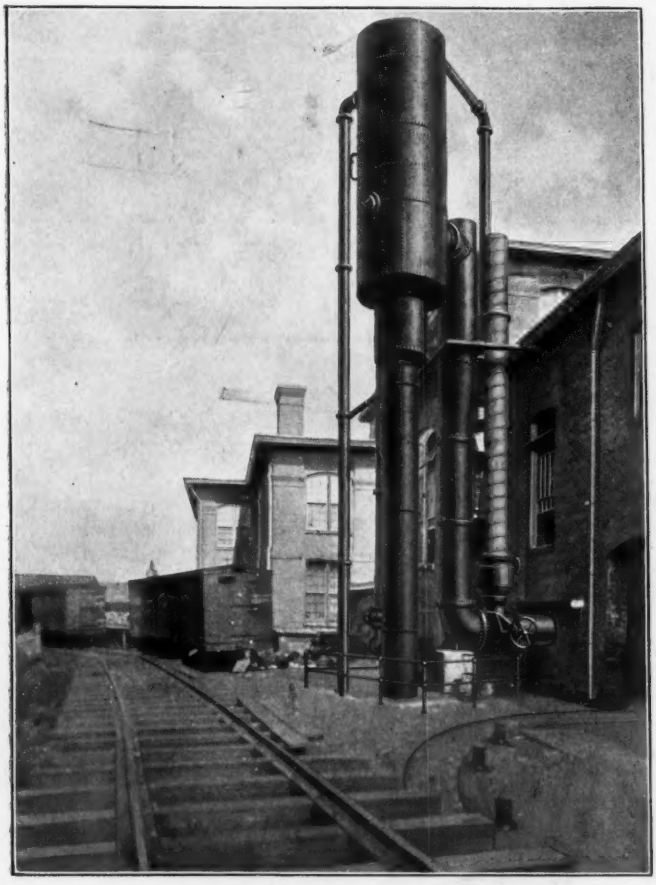

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Partial Table of Contents

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INDEX TO VOLUME XXI

JANUARY TO DECEMBER, 1916

A

Accident in Boston Tunnel..... 8090
Accidents and Popular Beliefs..... 8094
Acetylene Gas Corrosive..... 7999
" Lamp Consumption..... 7902
Aerial Post Service..... 8191
Aeroplane Carries Supplies to Mine..... 8058
" Industry, Growth of..... 8094
Afternoon Inefficiencies..... 7999
Air Balanced Hoisting Engine..... 8205
" Blasts in Mines..... 8108
" Compressors, Contractors' Portable... 8168
" Cools Open Hearth Furnaces..... 8062
" Determines Fineness of Cement..... 7850
" Friction Speedometer..... 8021
" Gun for the Movies..... 8158
" Hammer Helps out..... 8220
" in Compression and Expansion..... 7932
" Instead of Water in Dry Consentrating..... 8031
" Lenses for Diver's Spectacles..... 8039
" Lift for Ground Water..... 7850
" " Hastens Leaching..... 7958
" " at Old Dominion Mine..... 8023
" " in Cyanide Plant..... 8675
" " Power Cost of..... 7960
" " Pumping, High Duty..... 8118
" " Quebec Bridge..... 7926
" " Raising Oil by..... 8013
" " Successful Small..... 8012
" " Suggestions..... 7985
" Mains Convey Water for Fires..... 7850
" Operated Shovels in Tunnels..... 8055
" Pressure for Auto Tires..... 7862
" " Sprinkling Car..... 8179
" Propellers for Boats..... 8180
" Siphon for Gas Retorts..... 8077
" Shocks that Kill.....8029, 8156
" Supersedes Steam Calliope..... 8093
" Tight Brass Castings..... 8175
Alaska, Enlarging a Tunnel in..... 8039
Alloy Steels..... 7963
Altitudes, Power Losses at..... 7988
Aluminum in Explosives..... 8191
" Powdered..... 8086
Amateur Electricians..... 8127
Ambitions Little Lady..... 8047
American Port Accommodations..... 8056
Anaconda, Biggest Copper Producer..... 8222
" Recovery..... 7903
Artificial Ice in Canada..... 8074
" " " St. Paul, Minn..... 8088
Asphyxiating Horses..... 8222
Atmospheric Humidity..... 8046
" Pressure, Health and Comfort..... 7959
" Problem in Deep Mines..... 8112
Automobile Plants, Magnitude of..... 7992
Aviation Apprenticeship..... 8195
" Future of..... 8121

B

Barometric Low Record..... 7902
Bell Telephone Costs..... 8157
Belt Tighteners..... 8011
" " Humidity and..... 8102
Belting, Notes on..... 8099
Beyer Barometric Condenser..... 8081
Big Little David, a..... 7944
Bigger than the Railroads..... 7992
Black Damp..... 8152
Blackboard Cleaner..... 8094
Blacksmith Shop in Alaska Mine..... 8053
Blasted Mosquitoes..... 8120
Blasting for Clams..... 8038
" a Ditch..... 7999
" with Liquid Air.....7916, 7996
" " " Oxygen..... 8198
" for Planting Apple Trees..... 7906
" Machine, Pocket..... 7902
Blow Guns for Cleaning..... 8030
Blower for Shelling Almonds..... 8092
Blowing Cotton and Wool..... 8093
Blowout in East River Tunnel..... 7962
Blue Print Paper Costs..... 7966
Boiler Explosions in Germany..... 7960
Bontempi Rust-Proofing..... 7913
Brasher Breakwater.....7962, 7980, 8086
Brazil, Rapid Tunnel Drive in..... 8040
" Statistics..... 7935
Breaking Boulders by Block-Holing..... 8122
Brown Coal in Germany..... 7965
Bullet, Noise of..... 7922
Business of Mining..... 8105
Burning Powdered Coal..... 8144
Bypass on Catskill Aqueduct..... 7843

C

Capacities of Extra Heavy Pipe..... 7998
Carbide Plant in Norway..... 8031
Carelessness Kills..... 7988
Catskill Aqueduct Bypass..... 7843
Cement, Air Determines Fineness of..... 7850
" Gun in Coal Mines..... 8213
" " " Mining Work..... 8107
" " for Waterproofing Dam..... 8125
" " Work, Cost of..... 7990
Chains, Nomenclature of..... 7966
Chance for Somebody..... 8216
Change of Gas Standard..... 8031
Cheapest Blower..... 8024
Cherry Pits..... 8031
Chinaman Runs Drill Sharpener..... 7998
Cleaning Fires by Compressed Air..... 7999
Coal Burned by Railroads..... 8148
" Burning Powdered..... 8144
" Cutters in Canadian Mines..... 8085
" Dust Explosion, Naval..... 8174
" Miners in British Army..... 8093
" Powdered, Pneumatic System..... 8175

306558

" Thin Seams, Punchers in 8163
" What there is in 8122
Combination Shot, the 8221
Compressed Air and the Railroads 7897
" at Inspiration Mine 8181
" " at Rockland Lake 8035
" " for Concreting 8055
" " " Sinking a Shaft 8048
" " " Fire Whistle 7984
" " in Construction and Repair 7892
Compressed Air in Mattress Manufacture. 7882
Compressed Air Equalizing at Copper Queen 7885
Compressed Air Lining a Tunnel 7847
" " Pulls by Pushing 7978
" " Safety of in Mining 7858
" " Saves Shoes 8022
" " Solves a Water Problem .. 8060
Compressed Air Throws Bombs 8158
" " to Save a Park 7929
" " Tunnel Ventilation 7860
Compressor, a Hilarity 8013
Compressors Down in the Mine 7954
" High Speed for Mines 7907
Concrete Conveying, Pneumatic 7982
Concrete Mixer and Pneumatic Conveyor. 8111
Concrete Surfaces, Roughening 8197
Concreting Twin Peaks Tunnel 8189
Condenser, Beyer Barometric 8081
Continuous Gas Light 8190
Contractors' Portable Compressors 8168
Cooling Tower, Largest 8191
" Water for Compressors 8185
Cooperation of Engineers with Government 7945
Copper for Shells 7870
" " High Vacuum 8022, 8126
" Queen, Compressed Air at 7885
Cost of Crosscut Adit 8059
Costs of Mine Haulage, Horses and Air ... 8116
Cow, Food Productivity of 7965
Cracking of the Hydrocarbons 7994
Current from Sweden to Denmark 7965
Curtain of Air Jets 8055
Cutting off Piles 8157

D

Dam, Largest in Europe 8222
Danger in Copper Carbide Lamp 8024
Dangerous Mine Gases 8076
Deep Hole Drill Wagon 8003
Delay Cartridges 7988
Desiccation, Industrial 8084
Discharge Valve Trouble 7863
Distillate, Produced in Utah 8222
Ditcher and Grader, Railroad 7922
Diver, Narrow Escape of 8084
Diving Hood 8117, 8177
Don't Use Compressed Air 8164
Door Operating Pneumatic Engine 8080
Dover Strait Tunnel 8090
Drill Shanks and Bits 7946
" Steel and its Treatment 7916
" " Handling 7868
" " Resting 7922
" " Shanking 8133
" " Sharpening 8051
" " " at Old Dominion .. 8018
Drill Steels, Shanking 8133
" Tempering Process 8092
Drills for Cracked Rock 8110
" Tempering 7934
Drilling Contest 8093
" at Treadwell Mines 7976
Drying Air for Sand Blast 8186
" Films for the Movies 7944
Dust Explosion 8094
" " Preventing 8120
" to Prevent Explosions 8015
" Vacuum Conveyance of 8014
" Sand, Wind 8214

E

Earthquake Kills Miners 8092
Economies in Office and Mine 7957
Economy in High Class Equipment 7979
Edison Wireless Telegraphy 7849
Efficiencies of Compressors and Blowers .. 7952
Electric Air Drill for Blacksmith's Hammer 8050
Electric Air Drill Stamp Mill 7921
" " Heaters in Hospitals 8095
" Cooking of Snakes 8159
" Fans in Winter 8031
" Warm Air Blower 7870
Elephant Butte Dam 8094
Engineer, The 8184
Engineering Explosives 8072
Enlarging a Tunnel in Alaska 8039
Explosives in Engineering 7889
Extra Daylight 8073
Eye Protector Contract 8191

F

Factory Periscope 7960
Falling Pressure Safety Valve 8017
Fans Keep Frost from Windows 7881
Fire Fighting in Metal Mines 8187
" Resisting Materials Sought 8125
" Whistles, Compressed Air for 7984
First Aid in Gas Poisoning 8154
Fish Car 8152
Flags, Pull in Wind 8223
Flotation Parodox 7901
Flying Between France and England 8222
" Machines, Men Employed 7966
Foam Blankets for Oil Fires 8156
Ford Auto Record 8031
Forest Products 8093
Foundation Job, A Typical New York 8103
Freezing of Air Pipes 7866
Fresh Air for Submarines 8190
Frozen Steel, Thawing 7990
Future of Aviation 8121

G

Gage, Inspection, for Hand Drills 8052
Gas from Street Manholes 8221
" Holders, Novel Construction 7960
" Lighting, First in Baltimore 8094
" Main Joint Welding 8069
" Our Dependence Upon 7966
" Well, Greatest Producer 7935
Gases from Explosives 8158

Gassed in the Trenches 8202
Gasoline Cautions 8204
Gasoline Engines, Aggregate Power of 7999
" Fires, to Extinguish 8126
" in 1915 8191
" Locomotives Bad for Mine Air 7978
" Outfit for Anchor Bolt Holes 8106
" Safety in Soldering 8213
" Tanks, Protecting 8094
" Vapor in Air 7895
Give the Compressor a Chance 7948
Glass Blackboards 7869
Gold in Gallipoli Trenches 7869
" " Sulphur Mining 8091
Government Egg Car 8126
Grain Conveyor, Pneumatic 8067
Greatest Pipe Line 7949
" Tunnel in the World 8079
Grouting to Stop Water Flow 7903
Gun, Short Working Life of 8061
" Velocities 8062

H

Hammer Drill Mine Records 8123
Hammers, Steam or Air 8199
Handbook of Casinghead Gas 8187
" " *Rock Excavation* 8218
Hand Drills in Structural Work 8009
Handy Diving Helmets 8177
Hard Hats for Safety 7869
Hay Fever Cure 8093
Heart Action at Great Altitudes 8011
Heating Value of Gas 8223
Hendonhall, Refloating of 7875
High Pressure Gas Feeding 7986
" " Turbo Compressor 8209
" Speed Compressors for Mines 7907
Highest Habitation in the World 8157
Hilarity Compressor 8013
Hoists, Pneumatic 7913
" Portable in Quarrying 8102
Hoisting Engine Air Balanced 8205
How the Windows were Broken 8131
Human Air Pump 8157
Humanizing the Societies 8153
Humidity, Atmospheric 8046
" and Belt Tightness 8102

I

Iodine Dangerous with Mercury Chloride 7999
Industrial Preparedness 7964, 8073
Inspection Gage for Hand Drills 8052
Inspiration Mine, Compressed Air at 8181

J

Jackhamers at Pozo Mine 8022
Joking with Compressed Air 7870
Joliet Water Problem 8060

L

Laboratory Wind Tunnel 7880
La Brea Fossil Beds 8074
Lake Titicaca 7965
Lamp for Signals 8061
Lead Mine Given Away 7999
Legal Status of Gas Compressors 8223
Lettering by Sand Blast 8117
Leyner Oil Furnace 7920
Lifting Ground Water by Air 7850
Limestone Quarry, Deep 8157
Lining a Tunnel by Compressed Air 7847
Liquid Air, a Company to Manufacture 8093
" " Blasting with 7864, 7916, 7996
" " Explosives 8027
" Oxygen, Blasting with 8198
Little Tugger Hoist 8177
Livingstone Channel, Dry Excavation 8211
Long Distance Advertising 8220
Lung Motors 7869

M

Machine Mined Coal 8222
Marble Quarrying, Technology of 8090
Mattress Manufacture 7882
Mechanical Kinship 7998
Medicine Droppers to Spit on the Hands 7870
Metal Mining in Bolivia 7876
Metals, War Scatters 7888
Metallic Air Connections in Austria 8031
Metric System Free to All 8217
" " in India Visionary 8126
" " Progress 7993
Mexican Mining Journal 8030
Mine Explosion, Marvel, Ala 8222
" Gases, Dangerous 8076
" Haulage Costs, Horses and Air 8116
" Sprinkling Car 8179
" Timber Treatment 7903
" Ventilation 8077
Mines, Atmospheric Problem in 8112
Miners Phthisis not New 8080
Miniature Air Motors 7902
Mining, Business of 8105
" Code, New One Wanted 7870
" Engineers in the War 7901
Moisture in Fog 8157
Morningside Park Pump 7939
Mosquitoes, Blasted 8120
Motor Cars in America 8093
Mule has Right to Kick 8094
Multiple Effects of Improvements 8057

N

Nails Climb out of Wetted Wood 7999
Nation's Engineers to Help 7897
Natural Bridges in U. S. 8222
" Gas Compressors 7931
" " Consumption 8191
" " Pipe Line 7965
New Year Optimism 7865
Nitrogen, Growing Appreciation of 8108
Noise of a Bullet 7922
Norway, Shaft Sinking in 8202
Notes on Belting 8099
"Notowl" for Drying Face and Hands 8045
Nova Scotia Steel and Iron Co 8190

O

Odd Job for a Jackhamer 8119
Oil in Air Hose 8026
" Firing Explosions 8062
" Fuel Stored Under Water 7966
" " Supplied at Sea 7902
" Output of the World 8158
" Wells, Air to Help 7902
Oldest U. S. Bureau 8088
One Thing Leads to Another 8188

Operating Costs of Railroad Compressors. 8207
Osmium, Heaviest of the Metals..... 8031
Oxy-Acetylene Cuts up Boilers..... 7930
Oxygen and Nitrogen Company..... 8091
" Torch Cuts Armor Plate..... 8157
Ozone in War Surgery..... 8188

P

Panama Canal, Lighting the..... 8008
Patents—7871, 7903, 7935, 7967, 8000, 8032, 8062, 8095, 8127, 8159, 8191, 8223
Pennsylvania Steam Power..... 7947
Permutit..... 8094
Perpetual Motion, Compressed Air for.... 8174
Phonographic Weighing Machines..... 8150
Photographs, for Better Tunnel..... 7921
Pipe Rifling Suggestion..... 8120
Piping for High Pressure Gas..... 8029
Pneumatic Augers for Submarine Boring.. 8148
" Blacksmith's Hammer..... 7898
" Concrete Conveying..... 7982
" Concreting Saves Space..... 8119
" Grain Conveyors..... 8067
" Hoists..... 7913
" Incident, a..... 8008
" Lathe Grinder..... 8221
" Mail Tube Legislation..... 8126
" Massage..... 8017
" Press for Railroads..... 8115
" Tamping Reduces Gangs..... 8165
" Tires, First Manufacturers... 8114
" Tools, Care of..... 7919
" " In Automobile Work.... 7878
" Transfer of Liquids..... 7860
Pneumatics for Measuring Hides..... 7902
" to Teach Phonetics..... 8198
Post Hammer..... 7891
Powdered Coal, Pneumatic Burners..... 8175
Power Distribution in Blowing Engines... 7991
" Losses at Great Altitudes..... 7988
" from Volcanic Heat..... 8207
Preparedness, Industrial..... 8073
" for Peace or War..... 8025
Pressure in Peanut Oil Extraction..... 8197
Preventing Freezing of Air Brake Pipes... 7900
Professor Sweet, Death of..... 8026
Progress..... 7993
Projectiles, Air Resistance to..... 8095
Pulling by Pushing..... 7978
Pulmotor Improvement..... 8072
Pump Works under Deep Water..... 8158
Pumping Problem, Morningside Park..... 7939
Punches for Thin Cold Seams..... 8163
Pure Iron, New Method for..... 7884
Purifying Mercury..... 7949
Putting the Clock Back..... 8054

Q

Quack Electricians..... 8127
Quarries War Destroys..... 7944
Quarrying at Edge of Ocean..... 8023
" Practice, Ancient and Modern . 7951
Quebec Bridge Air Lift..... 7926

R

Railroad Ditcher and Grader..... 7922
" Ties for Kindling Wood..... 8182
Rats in the Trenches..... 8157
Record, a Patent Office..... 8093
Refloating of the Hendlonhall..... 7875
Refrigerating Systems..... 8172
Rescue Apparatus Independent of Altitude 7869
Rescuer Loses Life..... 8222
Resting Drill Steel..... 7922
Rights of Weighers and Measurers..... 7994
Rock Drilling by Contract..... 7965
" " Twelve Years Progress.... 8082
" Dusting to Prevent Explosions.... 8015
Roosevelt Tunnel Record..... 8176
Rotary Replacing Reciprocating..... 7966
Roughening Concrete Surfaces..... 8197
Rubber for Tires..... 7965

S

Safety First Slogan..... 7956
" Valve for Falling Pressure..... 8017
Saline Matter in Ocean..... 7864
Sand Blast in the Foundry..... 8136
" " for Lettering..... 8117
" " Reheating the Air..... 7965
" Blasting Data..... 8222
" " Forgings..... 8087
" " Glove..... 8083
" " Material..... 8156
" " a Water Tank..... 8155
Sappers and Miners, The..... 8184
Saving with Cheap Coal..... 7979
" Old Tracing Cloth..... 8158
Sawdust for Gasoline Fires..... 8126
Screw Pipe Joints..... 7898
Seeing Stars in Daylight..... 8126
Self Pumping Wells..... 8125
Shaft Sinking in Granite..... 8158
" " " Norway..... 8202
" " Methods, Three..... 8019
Shanking Drill Steels..... 8133
Sharpening Drill Steels..... 8051
" Steels at Old Dominio..... 8018
Shipping Ports of U. S..... 8093
Shop Signals..... 8092
Sick Drill..... 8152
Signal Code for Field Engineers..... 8189
Silver Exports from Mexico..... 8031
" in the Moving Pictures..... 7903
" Rivet instead of Corner Stone..... 7903
Skin Eruption from Handling Cement.... 7967
Small Air Lift, a Successful..... 8112
" Drill for a Small Tunnel..... 7950
Soap Bubble Lives Five Weeks..... 7992
Socks of German Soldiers..... 8158
Sooy Smith, William, Death of..... 7961
Speedometer, Air Friction..... 8021
Spring Banding Press..... 7921
Stainless Steel..... 7999
Stamp Mill, Electric Air Drill..... 7921
Steam or Air Hammers?..... 8199
" for Melting Soft Metal..... 8182
" Turbine, Long Run..... 7870
Steam Power, New Book..... 8154
Structural Work, Hand Drills in..... 8009
Subway Excavation Revolutionized..... 7971
" Stations, Papers and Dirt..... 8093
Suggestion, Value of a..... 8058
Sulphur Mines, Largest Power Plant..... 8216
Super Zepelin Data..... 8222

T

Tamping, Pneumatic Reduces Gangs.... 8165
" Trench Filling..... 8045

Tarpaulin 8164
Telescope Tells of Air Currents 8024
Temperature Limits in Mines 7925
" of Ocean Depths 7930
Tempering Mine Drills 7934
Tests of Rock Drills 8030
Thawing Frozen Steel 7990
Three Shaft Sinking Methods 8019
Tie Tamper, Rapid Spread of 7997
Tin from Bolivia 8190
To Tunnel Under a Town 8093
Too Much Funny Business 7869
Treadwell Mines, Drilling at 7976
Tungsten Lamp Gas Pressure 8020
Tunnel Drive in Brazil 8040
" Greatest in the World 8079
" in Hawaii 7902
" Record in Burmah 8093
" " " the Courts 7925
" " Subaqueous 8056, 8089
" Rogers Pass 8092
Tunnels, Ventilating 8122
Tunneling Heroes of the War 8170
" Machine Demonstration 8218
Turbo Blower, New 7996
" Compressor, High Pressure 8209
" Compressors and Blowers 7928
Turkish Irrigation Project 8220
Twelve Years Progress in Rock Drilling .. 8082
Twenty-four Hour Day 7965
Twin Peaks Tunnel, Concreting 8189
Two Things Less than each Other 8132
Typical N. Y. Foundation Job 8103

V

Vacuum Cleaner to Gather Pollen 7965
" Conveyor of Fine Dust 8014
" Pump, Home Made 7987
" " New Type 7956
" Transportation of Dust 7962
Variety of National Products 7870
Ventilating Tunnels 8122
Ventilation, Mine 8077
Volcanic Heat, Power from 8207

W

Wages in Steel Industry 8031
War Consumption of Metals 7848
Washing out Water Jackets 8078
Water Highway and Gliding Boat 8056
" Power and National Defence 8058
Waterproofing with Cement Gun 8125
"Wave" Power for Rock Drills 8079
Weighers and Measurers, Rights of 7994
Welding Joints in Gas Mains 8069
West Clare Railway of Ireland 8126
Wet Flour 8061
What There is in Coal 8122
Where Wages Haven't Gone Up 8183
Wind Cave 8171
" Velocities and Wave Heights 8221
World's Largest Oil Well 8026
Wrecking Gas Pumping Stations 7930

Tantalum 8164
Telescope Tube or Air Current 8165
Temperature Limits in Mine 7937
" at Lower Depths 7939
Tamping Me Drills 8139
Testing Rock Drills 8140
Thawing Frozen Soil 8000
Three Shift Sinking Methods 7907
Tie Clamps, Rapid Turned of 8170
Tin from Bolivia 8007
To Tunnel Under a Town 7880
Toe Nib-Pump Bucket 7920
Treadwell Mines, Drilling At 7870
Tungsten Lamp Gas Pressure 8010
Tunnel Drive in Brazil 7878
" Courses in the World 7877
" in Hawaii 7879
" Record in Bernina 7876
" " " the Cape 7875
" " Subaqueous 7880a
" Route Pass 7874
Tunnels, Ventilating 8172
Tunneling Horses at the War 8170
" Machine Demonstration 8173
Turbo Blower, New 8218
" Compressor, High Pressure 7900
" Compressors and Blowers 8240
Turkish Irrigation Union 8210
Twelve Years Progress in Rock Drilling 8007
Twenty-four Hour Day 7964
Twin Docks Tunnel Concreting 8132
Two Things Less than each Other 8132
Typical N. Y. Foundation Job 8164

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XXI JANUARY, 1916 No. 1

FIG. 2. IN FRONT OF SHAFT 8. DAMAGED PORTION OF OLD TUNNEL.

BYPASS AROUND LEAKY TUNNEL OF CATSKILL AQUEDUCT

BY CHARLES A. HIRSCHBERG.

Driving a shaft and tunnel supplementary to the Moodna pressure tunnel, which connects with the Catskill Aqueduct tunnel under the Hudson River at Cornwall, N. Y., to stop leakage from a damaged section, is practically the last chapter of the gigantic water-supply project of New York City. The work itself is complete now, two months in advance of the time specified by the Board of Water Supply of New York City. There remains only the work incident to tearing out track, cleaning up and sealing the damaged and leaky section. The actual driving and concrete lining of the tunnel and connecting shaft have been finished some time; in fact, the majority of the surface equipment has been boxed and shipped to other work.

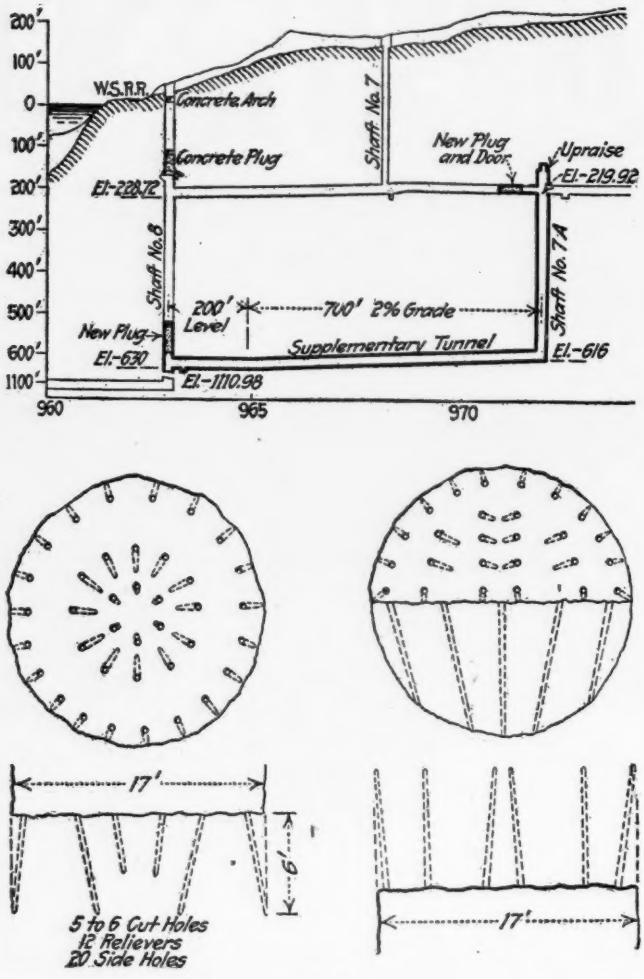

FIG. I.

The original work was carried on through two shafts, known as No. 7 and No. 8, shown in the profile, Fig. 1. No. 8 shaft formed the connection between the siphon under the river and the main water-supply tunnel and had been permanently sealed. No. 7 shaft was driven as an access shaft and was left open to permit operation of the aqueduct. The cracks which developed in the old tunnel are located near Shaft 8 and extend part way toward Shaft 7.

When it was decided to replace the damaged section the plan adopted was to drive a new tunnel section parallel to the old, but located 400 ft. below it. To save time and expense the contractor was required to utilize Shaft 7 (8 ft. 8 in. in diameter) for handling all materials. This necessitated sinking a supplementary shaft (designated No. 7A), 17 ft. in diameter and 400 ft. deep, from a point within the old tunnel and driving a new tunnel 17 ft. in diameter and 900 ft. long. The latter formed the new connection between the siphon and the main water tunnel. A concrete lining reduced both shaft and tunnel to approximately 14 ft. 2 in. in diameter.

PROVISION FOR HANDLING MATERIALS.

The contract was awarded to the Oscar Daniels Co., New York, and the work of installing equipment began in the latter part

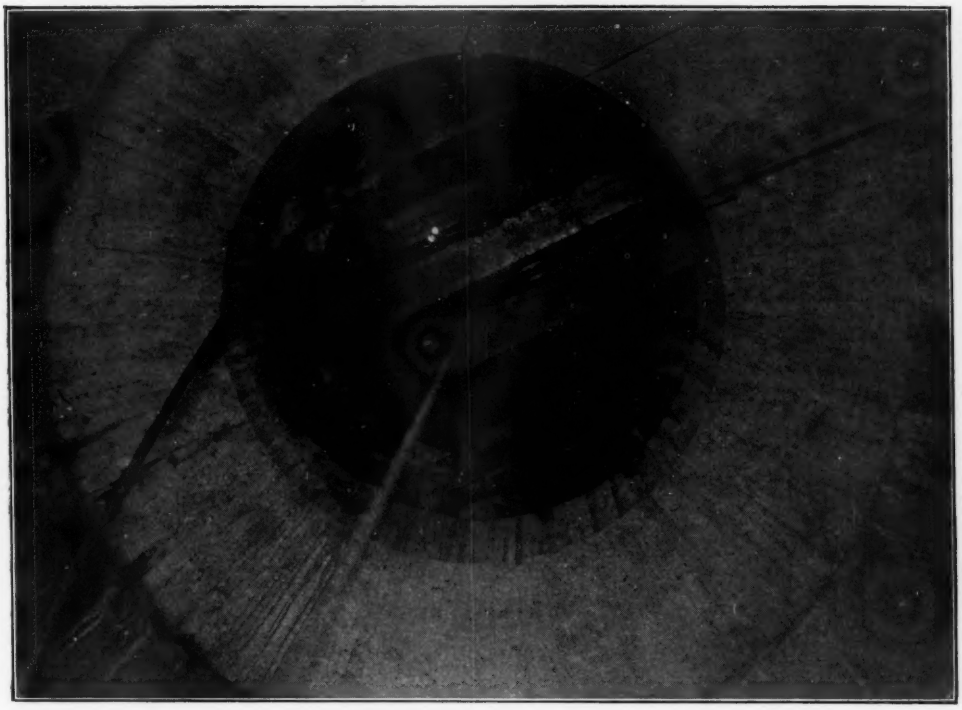

FIG. 3. LOOKING UP INTO UPRAISE OF SHAFT 7A.

of November, 1914. Active work on Shaft 7A was not started until Jan. 2, 1915. The time intervening was devoted to installation of the surface plant, placing guides and apparatus for operating a cage in Shaft 7 and driving a dome or upraise over the location of Shaft 7A for hoisting headframe purposes. Preliminary work also included the installation of a platform at a point in Shaft 8 where the new tunnel was to be started.

It was at first thought feasible also to utilize Shaft 8 for handling materials directly from the new tunnel to the surface. This shaft, however, had been sealed at the top by a concrete dome and also by a concrete plug 50 ft. thick and 30 ft. above the old tunnel, so that the idea of using this shaft was abandoned. Blasting operations for the removal of the 50-ft. plug would have endangered the shaft lining. The concrete dome, however, was removed, and the novel idea was conceived of utilizing the portion of Shaft 8 between the new and old tunnel levels by drilling two 8-in. holes through the plug with a core drill. One hole was used for passing the hoist cable from the surface for handling a cage and the other for chuting concrete for the tunnel and shaft lining.

The tunnel work was prosecuted entirely from Shaft 8.

Fig. 2 is a view in front of Shaft 8, showing, at the left, a portion of the damaged section of the original tunnel.

The first round was blasted on Feb. 6, 1915, and the last or breaking-through round on May 20. Driving the tunnel and sinking the shaft were completed at about the same time.

DRIVING AN UPRAISE.

Fig. 3 is a view looking up into the dome or upraise in Shaft 7A. Work in this upraise, which was 17 ft. in diameter and 31 ft. high, was necessarily slow, owing to the need for continual building of temporary staging, which had to be torn out prior to blasting each round. Work was started on Dec. 31, 1914, and was completed Jan. 17, 1915. Three stope drills were employed for the drilling. The dome was concreted to form a setting for the hoisting headframe with its

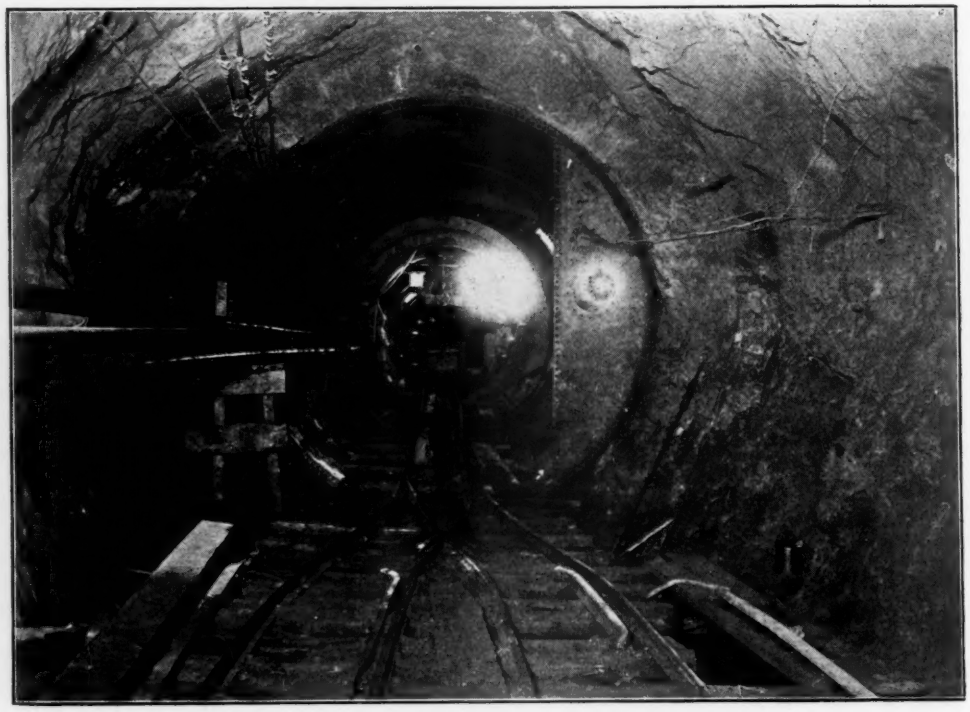

FIG. 4. WHEN NEW WORK WAS STARTED ON SHAFT 7A.

sheaves and to eliminate danger incident to rock sloughing off.

SINKING SHAFT NO. 7A.

In Fig. 1 is a diagram of the drilling round in the shaft. This round consisted approximately of 38 holes. For drilling the shaft as many as six heavy hand hammer drills (Ingersoll-Rand Co. "Jackhamers," Bull Moose size) were employed at one time. The day was divided into one 8-hr. drilling shift and two 8-hr. mucking shifts. All holes were started 2 in. and bottomed 1⅝ in. 1¼ in. powder. The first round in the shaft was blasted on Jan. 22, 1915, and the entire sinking of 400 ft. was completed in 76 rounds, giving an average advance per round of 5.26 ft. After sinking 306 ft., drilling was stopped for 26 days to do concreting, and was resumed again on Apr. 20. In portions of the shaft it was necessary to employ temporary steel lining.

All hoisting in Shaft 7A was handled by bucket, except in the case of the spoil, when the transferable bodies of the 2-ton steel cars were used.

DRIVING THE SUPPLEMENTARY TUNNEL.

The supplementary tunnel, 17 ft. in diameter and 900 ft. long, was driven by the usual heading-and-bench method. The round (in Fig. 1) consisted of 26 to 28 holes in the heading and five holes in the bench.

Work in the tunnel was started from a platform placed in Shaft 8. The first round was blasted on Feb. 6 and holed through on May 20, during which time 206 rounds were drilled, blasted and mucked, giving an average advance of 4.37 ft. per round. The drilling and mucking may be said to have proceeded simultaneously. The first drilling crew worked from 8 a. m. to 4 p. m. and the second from 8 p. m. to 4 a. m., while the first and second mucking crews worked from 4 p. m. to 12 midnight and from 4 a. m. to 12 noon. Holes in the heading averaged from 7 to 8 ft. deep, and from 6 to 8 ft. deep in the bench. All holes were started 2 in. and bottomed 1⅝ in. Changes of steel averaged 24 in. Four No. 18 Leyner-Ingersoll water drills on two columns were employed in drilling and heading. Two drills of the

same type set up on tripods drilled the bench. Each machine was manned by two men. About 150 lb. of 1¼-in. "gelatin" was consumed per blast in the tunnel and 90 to 100 lb. in the shaft.

Air was furnished by two 1,200-ft. motor-driven Imperial air compressors, a pressure of 90 lb. being maintained at the drills. The air was conveyed both to the tunnel and the shaft by means of two 4-in. air lines. Water for the drills was taken from the leakage in the tunnel. All haulage was performed by storage-battery locomotives. Lining the tunnel started after holing through. Blaw steel forms being used. The smoothness of the concrete lining of this work is a feature worthy of note.

ENGINEERS AND CONTRACTORS.

D. E. Baxter and C. L. Ostenfeldt supervised the work for the Oscar Daniels Co., S. A. Knowles being Superintendent. The engineers of the Board of Water Supply were George J. F. Carey, Field Engineer, and W. B. Hoke, Section Engineer. Ralph M. Wheeler, Department Engineer of the Northern Aqueduct, was in charge for the Board of Water Supply under the direction of Alfred D. Flinn, Deputy Chief Engineer, and J. Waldo Smith, Chief Engineer.—*Engineering News.*

LINING A RAILWAY TUNNEL BY COMPRESSED AIR

The concrete lining of the double-track Diana tunnel on the Louisville & Nashville R. R. has been placed by the pneumatic system. The tunnel is 1,520 ft. long, in limestone and shale, and required timbering throughout. For about 300 ft. at the north end this timbering had to be removed in advance of the concrete, but for the remainder of the distance the tunnel section was large enough for the lining. Traffic was handled on one track.

Steel forms of the Blaw type were used, with steel plates for the side walls and 2½x5½-in. pine lagging for the arch. The sides were stiffened by vertical I-beams, against which were two lines of horizontal timbers secured to the rock by anchor bolts. Struts from the I-beams carried transverse members, on which were mounted jacks supporting the arch ribs. There were two sections of the forms, each 35 ft. long, traveling on rails. The sides of the forms abutted against the footings, which were built in advance of the forms.

The mixer plant was in the approach cut, about 75 ft. from the portal, working first at the south end and then at the north end. Spoil from the tunnel was crushed to form the coarse aggregate. Sand and cement were delivered by cars and hauled up incline tracks to the top of the material bins. The materials were supplied to a measuring hopper, which delivered 10-ft. batches to the mixer chamber beneath.

An 8-in. steel pipe was laid along the subgrade from the mixer to the forms and then turned vertically, ending in a Y with two 8-in. branches. These branches led into the crown of the arch for about 20 ft., each ending in an elbow at the side wall, with a 9-ft. length of 8-in. hose. Men with ropes pulled the hose to and fro to secure even distribution of the concrete. The concrete was deposited on one side till the wall was 2 to 6 ft. high; then it was diverted to the other side, in order to balance the pressure on the forms.

For concreting the arch, the hose, elbows and one branch pipe were removed and a short piece of hose attached to the remaining pipe. When the concrete reached the end of the hose, this was removed and the concrete blown in directly from the pipe. The forms were left in place for sixty days at first, but afterward the time was reduced to four days.

Where the temporary timbering was removed the cavities were filled with a packing of 55% limestone screenings and 25% sand, blown in by compressed air.

The work was done in 41 sections of 35 ft., containing about 250 cu. yd. each. The concreting of a section averaged 24 hr., with a minimum of 15 hr. The distance for conveying the concrete by compressed air averaged 400 ft., with a maximum of 925 ft. The force consisted of 13 men for concreting and 10 for constructing the footings and shifting the forms.

The work was done by the Meacham Contracting Co., of Hopkinsville, Ky., using the McMichael pneumatic plant supplied by the Concrete Mixing and Placing Co., of Chicago. It was under the supervision of H. C. Williams, Chief Engineer of Construction, Louisville & Nashville R. R. George B. Bryson was Resident Engineer.—*Engineering News.*

DEEP DIVING RECORD

In the raising of the ill-fated submarine F-4 in Honolulu harbor from a depth of 300 ft., a new world record for deep diving was made, as described by Naval Constructor J. A. Furer in Engineering News.

It was possible to send men down to this previously unattainable depth only by the use of special methods. The Bureau of Construction and Repair of the Navy Department had been experimenting for some time on deep-sea diving. It so happened that these experiments were brought to the point of practical application just before the accident to the F-4. Four divers, in charge of the officer who had been conducting the experiments, were ordered from the New York Navy Yard to Honolulu for this work.

The diver does not wear a suit of special character for working in great depths. The difference as compared to shallow-water procedure lies entirely in the method of supplying air to the helmet and in the scientific restoration of the diver's body to the normal state by gradual decompression as he comes up from deep water. Air is supplied from flasks charged to a high pressure—suitably reduced before being delivered to the diver's helmet. The dangers in deep-sea diving are due principally to the absorption of nitrogen by the fluids of the body, on account of the high pressure to which the lung tissues are subjected, and to the extreme exhaustion accompanying any kind of manual labor. For the latter reason the divers could not do heavy work at the 300-ft. depth, such as can easily be done by men working in shallow water. Their duties had to be limited to observing and reporting the conditions found below.

WAR CONSUMPTION OF METALS

Here is a single item suggesting something of the enormous consumption—the practically total disappearance—of the industrial metals used in modern "civilized" warfare. A British 18-pounder, or 3.3 in. shrapnel, requires 5 lbs. 9⅛ oz. of brass, containing 66% to 70% Cu, or nearly 3¾ lbs. A small copper band around the shell adds 4¾ oz., making the total copper 4.04 lbs. Spelter-consumption per shell of this size is about 1.87 lbs. Lead bullets weighing 7.92 lbs., and composed of 7 parts of Pb to 1 Sb, constitute the metal load of the projectile. Estimating the total orders for shrapnel and other shells placed in the United States by Europe at 25,000,000 shells, these orders would call for a total of 101,000,000 lbs. of copper, 46,750,000 lbs. of spelter, and 173,250,000 lbs. of lead. Actually the metal consumption is larger, as a fair proportion of the shells are 4.7-in. Howitzer shells, using more brass; some 6-in., 7½-in., and probably 9-in. shells are also being made. Rifle cartridges are composed mainly of copper, there being 1 lb. of it used in making 24 Lebel cartridges, a type widely used by the French army. Every 125 of these cartridges consume 1 lb. of spelter and a small amount of nickel. Steel consumption per shell varies more widely with the different types. A finished 3.3 in. shell contains 6 lbs. 15¼ oz. of steel; the steel shell weighing 6 lbs. 5¾ oz., and the diaphragm 9½ oz. If the shell is made from a steel bar, the weight of this is about 17 lbs., while a forging for the same purpose weighs approximately 14½ lbs., and a "bottle" made by the seamless tube process somewhat less.

DYNAMITE DITCH DIGGING

A ditch 400 ft. long and 12 ft. wide was recently dug with dynamite at Carney's Point, N. J., in one day at a cost of 15 cents per cubic yard. The ditch was across a mud flat from a sluice gate to the Delaware River. The ground was soft, water-filled mud covered with a dense growth of reeds. These were first cleared off for a width of 15 ft. along the line of the ditch. As the ditch was to be only 4 ft. deep, the holes were made by pushing a long shovel handle down full length. Three rows 4 ft. apart were made, with the holes 18 in .apart and 3 to 4 ft. deep. Each hole was loaded with two cartridges of 60 per cent. dynamite, one at the bottom and one about 18 in. from the top. Some of the holes in the middle row were loaded with three cartridges, two at the bottom and one 12 or 15 in. from the top. Electric blasting caps were placed every 50 ft., and fired with a No. 5 blasting machine. The result was a perfect ditch, which filled with water at high tide, 3 hours later. The dynamite cost $120 for the 800 lb. used, the exploders 50 cents, and the four men who did the work were paid $8, making a total cost of $128.50.

THE WIRELESS TELEGRAPH AT WORK.

EDISON WIRELESS TELEGRAPHY

The excellent photo here reproduced tells its own story very completely. It is well known that Mr. Edison is so deaf that he hears practically nothing of what is said at a public meeting so that he is accompanied at such places by Dr. Miller Reeves Hutchison, E. E., Ph.D., "Chief Engineer to and Personal Representative of Thomas A. Edison," who communicates with him constantly by tapping with his finger on wrist or knee as here shown, using the Morse code. It is well known that Mr. Edison's first activities were as a telegraph operator, so that communication by this means is like play to him.

Dr. Hutchison, of course, attends all meetings of the Naval Consulting Board with Mr. Edison, and has been made a member of that body. He recently gave an address on the Life of Thomas A. Edison before a gathering of electrical engineers at the close of which he invited questions which brought out many phases of the private life and the dominant human element.

Mr. Edison finds no pleasure in horseback riding. He tried it once and got enough. Desiring to master the art immediately he spent a considerable time in riding his steed before dismounting. The resulting discomfiture and inability to sit down without an ache for a week discouraged all future efforts. Mr. Edison seldom smokes, considering it effeminate, and that it is far more masculine to chew. He cares little for publicity and counts his deaf-

ness as his greatest fortune. At public dinners Dr. Hutchison keeps him informed of what is said, and at a recent affair when unlimited praises were dealt out, Mr. Edison promptly telegraphed back, "Oh, hell." Mr. Edison is quick also at other styles of repartee, and seldom misses an opportunity for a flash of wit.

AIR TO DETERMINE THE FINENESS OF CEMENT

In the mechanical analysis of cement it is not practicable to use a sieve finer than 200 mesh. Most specifications require that at least 75% of the cement shall pass the 200 mesh but even then some of the material might still be too coarse to be acted upon by motor, and it thus would be practically inert materials. For a finer separation, elutriation methods in which the desired separations are accomplished by washing or blowing, are necessary. J. C. Pearson and W. H. Sligh discuss this matter in Technological Paper No. 48, recently issued by the Bureau of Standards.

Two types of apparatus are used, one employing a liquid and the other a gas. Gas or air-analyzers are believed to be the best for cement, and the investigations of the authors were confined to this type. After a series of experiments with the kinds of apparatus at present in use, an analyzer was developed that gave reliable results which could be used as a basis for comparison with tests made with other analyzers. It was possible to separate the finer material into particles having an average diameter of 0.001 in., 0.002 in., and 0.003 in. respectively, and the determinations were accurate within 2%. While the investigation has so far been rather fragmentary, enough has been accomplished to show the importance of a more complete analysis than can be obtained by the use of sieves, especially in the study of the effects of fine grinding. The air-analyzer can also be used in studying the properties of other powdery materials than cement.

At the Mount Morgan mines in Australia, the air mains can be supplied with water for fire fighting purposes. The water is under a high pressure and this idea has been found highly satisfactory.

LIFTING GROUND WATER BY COMPRESSED AIR*

The purpose of this paper is to describe in an elementary way the present condition of the art of lifting water from wells in the ground, usually driven, by the use of compressed air. This is commonly called the air lift system as distinguished from direct mechanical pumping.

All water distributed over the earth is normally rain water, and that found in the ground is what has not been carried to the sea by the rivers. In the western part of the United States the rainfall is much less than in the eastern portion and much of the rain goes into the ground, percolating through the sands, porous rocks and fissures, while that over the surface rapidly evaporates, leaving the soil dry. In the east with more rainfall and less evaporation the soil remains more moist but much water runs into the lakes and streams which carry it to the ocean. It has been estimated that from 80 to 90 per cent of the rainfall finds its way beneath the surface of the earth, some of it to great depths, yet vast volumes are easily recoverable by pumping from driven wells with suitable apparatus.

Water was first obtained from the earth strata by dug wells and lifting buckets. Later on endless chains were introduced, followed by screws and other mechanical devices, until the piston pumps, first operated by hand and later by mechanical devices, replaced the earlier systems because of the increased volumes obtained.

The old-time well, although widely employed, was of limited capacity and usefulness. It could not be dug to great depths and hence the art of well driving, as distinguished from drilling, was developed, and now the driven well has replaced the open well for nearly all practical purposes. Driven wells may be carried to great depths, thousands of feet, tapping successively several subterranean streams and thus obtaining a great aggregate from the one installation.

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*Paper by W. L. Saunders, presented at the second Pan American Scientific Congress, Washington, D. C., Dec. 27, 1915—Jan. 8, 1916.

The term "artesian" applies to driven wells which tap communications with natural reservoirs of water such as lakes or other bodies of water situated at a distance and at a higher level than the well itself, but all deep wells are not necessarily artesian. They may connect only with subterranean strata containing rain water, the advantage of the depth being in the increase of the volume of supply, the level of the water in the well rising to such a point as is represented by the various depths of the underground streams.

[The description of the operation of driving these wells and of the various devices employed, as embodied in the paper, cannot be printed here on account of lack of space. Ed. C. A. M.]

Having drilled the well we may at times find that it flows at the surface, but this flow may not be sufficiently rapid to give the desired capacity, hence, even in normally flowing wells, the general practice is to pump. The pumping action almost invariably lowers the level of the water in the well to a certain point where it then remains approximately stationary when the pump is at work. This condition indicates and fixes the normal capacity of the well.

Before the invention of air lift systems the practice was to lift the water by mechanical means; that is, by a pump located at or below the surface, according to the level of the water in the well, the pump sometimes being constructed to go down to considerable depths in the well, the water being lifted by the pumping action of pistons operated by mechanical means through steam, hydraulic, electric or other sources of power.

Every system of mechanical pump action is limited in its capacity and incapable, except in large units, of giving at times the full water capacity of the well. It requires attention, is subject to wear and tear, and where the apparatus is located underground it cannot be readily adjusted, and, as water is not a good lubricant, the wear and tear is an item of consequence.

The air lift system removes all mechanical action from the well itself. There are no valves or reciprocating parts within the well to clog or get out of order. All the apparatus is located on the surface, in a clean, light engine room, where it is seen and cared for by a competent mechanic. All that goes into the well is a system of piping arranged to receive compressed air, which is carried down to a considerable distance below the level of the water.

The first and simplest form of air lift is that known as the Frizell system, a system which will not be illustrated or described

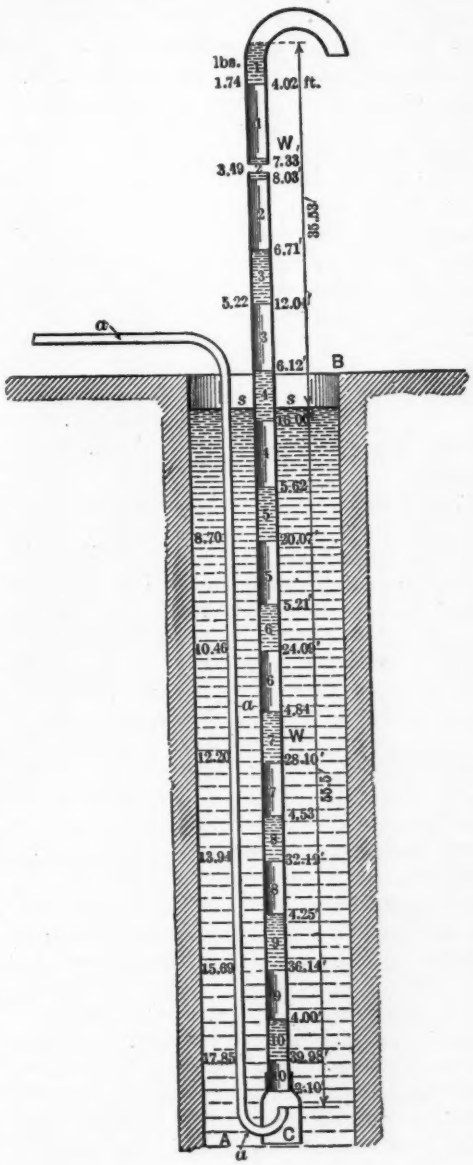


FIG. I.

here because it has never been generally used. The Frizell system gave the first thought to pneumatic engineers, who carried the air lift many steps further, and made from what was little more than a laboratory experiment a practical and useful system of pumping. Frizell introduced bubbles of air into a pipe, which was inserted below the level of the water in an open ended pipe which was also inserted below the level of the water, the air being injected at or near the bottom, thus aerating the air within the pipe, giving it, as it were, a champagne appearance, which lightened the column of water in the pipe.

The first successful air lift used on a large scale is known as the Pohle system. Following this came the Saunders system. All other air lift pumps, and there are many of them in practical operation, involve more or less modification of apparatus, but the principles governing them may be found in either the Pohle or the Saunders system.

The Pohle air lift pump is shown in Figure 1.

The Pohle system is briefly described as follows:

Two properly proportioned pipes are placed in a well, the one an air pipe leading from the Air Compressor and connected with the other pipe, the water discharge pipe, near its base through what is known as the foot—or end—piece. The compressed air is forced through the air pipe into the foot piece and the water pipe, and by its inherent expansive force, layers or pistons of air are formed in the water pipe, which lift and discharge the layers of water through the upper end of the water discharge pipe above the water level of the well.

At the beginning of the operation, the water surface outside of the pipe and the water surface inside of the water pipe are at the same level; hence the vertical pressures are equal at the submerged end of the pipe, outside and inside. As the compressed air is forced into the lower end of the water pipe, it forms alternate layers with the water, so that the downward pressure of the column thus made up of air and water, as it rises inside of the water pipe, is less than the pressure outside of the pipe. Owing to this difference of pressure, the water flows continually from the outside to within the water pipe by gravity, causing the column of air and water to rise, and its ascent through the pipe is free from shock, jar, or noise.

As each air stratum progresses upwards to the spout, it expands on its way in proportion as the over-lying weight of water is diminished by its discharge, so that the air pressure, which may have been, say 50 lbs. per square inch at first, will be only 1.74 lbs. when it underlies a water layer of four feet in length at the spout, until finally this air section when it lifts up and throws out this four feet of water, is of the same tension as the normal atmosphere.

The foregoing is the theoretical action of the Pohle pump. Practically it does not follow the lines indicated, due to slippage of the water pistons through the air bubbles, but mainly because of improper design of the piping system, and the proportion which the air pressure bears to the head of water.

When the compressed air is forced to a point within and at the lower end of the open ended discharge pipe the first effect is to blow out, en masse, the entire volume of water within the discharge pipe, which action naturally produces a vacuum effect within the pipe, the result being that the water surrounding the pipe rushes in, is caught by the incoming air pressure, and thus an intermittent struggle takes place between the head of water outside the eduction pipe and the pressure of compressed air, one first gaining supremacy and then the other, but all moving upward through the eduction pipe because of the momentum given the entire mass through the first impulse created by the air.

Many attempts have been made to develop mathematically theories of the air lift pump, but it is doubtful whether any of them are correct because of uncomputable conditions. If no slippage took place within the discharge pipe, or, in other words, if the air followed the water in well defined piston layers from the time it started at the bottom until it reached the surface, there would obviously be an action equivalent to that of a perfect expansion engine.

Such conditions are impossible of attainment, and even if obtained the air bubble might be larger than required to discharge the maximum quantity of water, hence it has been found best to split up the air before it enters the discharge pipe, and for this pur-

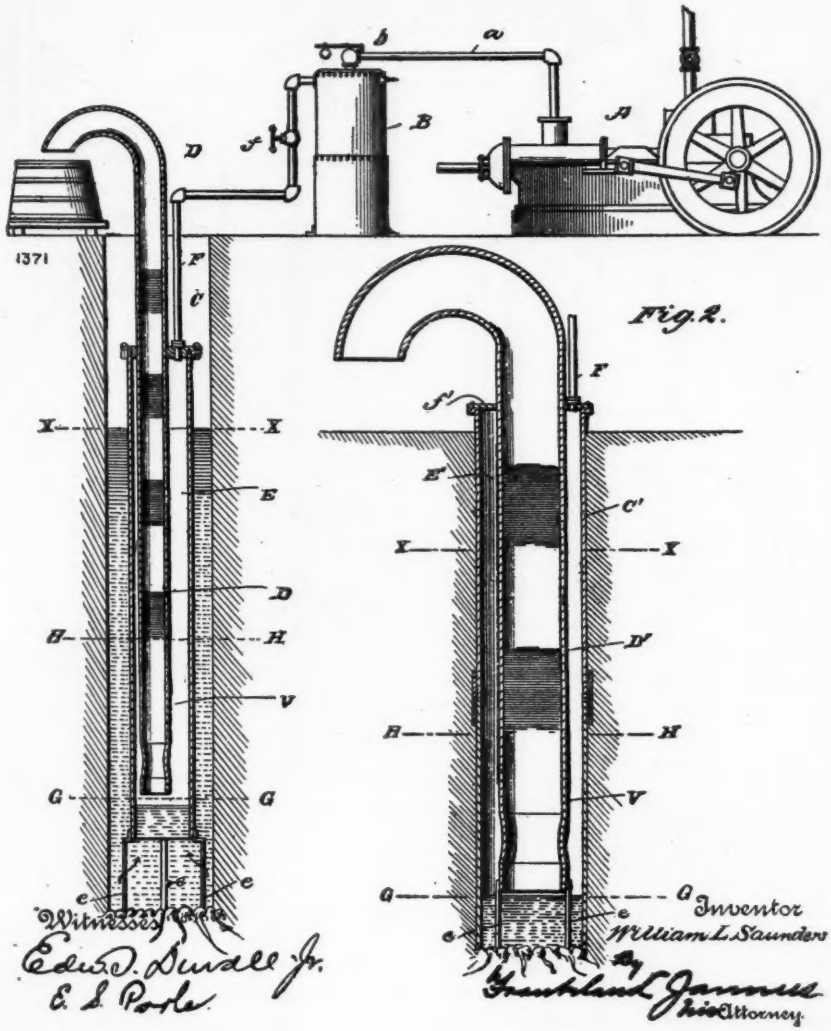


FIG. 2.

pose perforated screens or foot pieces are used, which serve during the constant operation of the pump to permit only as much air to be blown into the water column as will be sufficient to keep this column moving upward to the point of discharge.

When the pump is first started it is likely that in order to blow out the column en masse most or all of these perforations are in action and an uneconomical condition exists, but this is only momentary, because after the first impulse the relation between the head of water, the diameters of the pipes and the air pressure establishes a state of equilibrium which automatically causes the water to cover some of the lower perforations and in this way to restrict the admission of compressed air to that only which is required to keep the aerated column moving upward.

Figure 2 shows the Saunders system. In this there is a pressure chamber, formed either by a well casing or through an open ended air chamber surrounding the eduction pipe. The air is admitted to this pressure chamber, forcing the water downward until

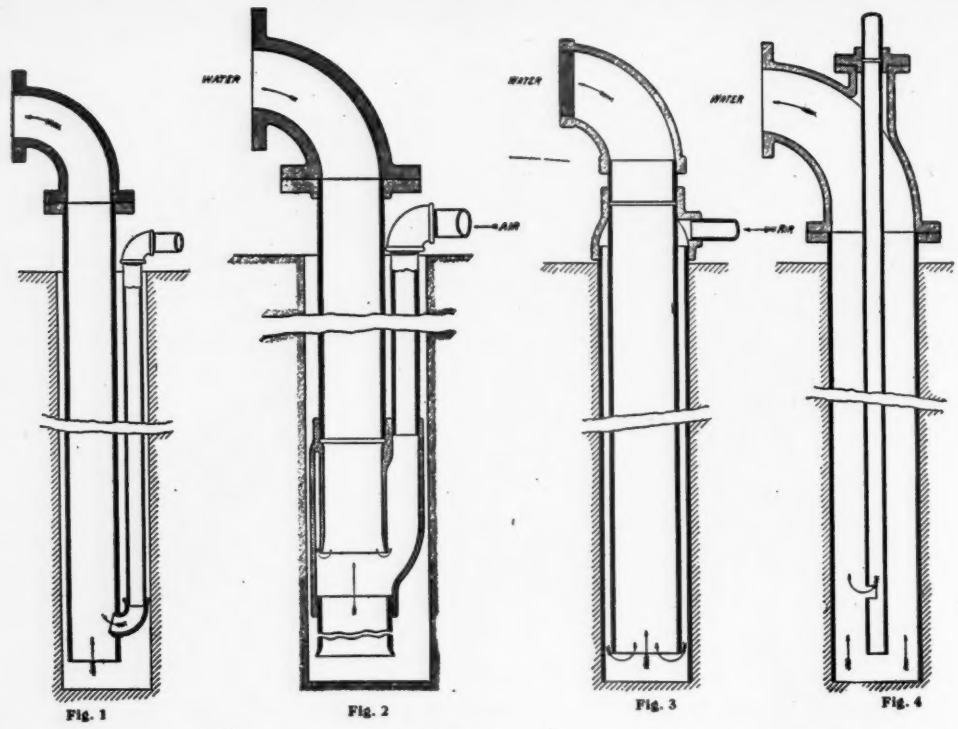


FIG. 3.

its level is at or below the open end of the eduction pipe. At this point the compressed air from the chamber enters the discharge or eduction pipe and this loss of air escaping upward slightly lowers the pressure of air in the chamber, which causes the water to rise to a point balanced by this pressure loss. This action causes the water to again cover the lower end of the discharge pipe, and the air accumulating in the chamber again lowers this level, and so an intermittent action or pulsation of air and water takes place, alternately cutting off the air and water and causing columns or chunks of air and water to rise within the discharge pipe. The action of this pump has been shown in glass models to be as described, air being blown in steadily and the water rising in the discharge pipe in well defined sections, mixing with the air only at or near the surface or upper end of the pipe.

In a glass model, capillary attraction causes a more perfect division between the air and water, but the main point is that it shows the pulsating action. The best designs for this system do not admit the air to the open end of the water discharge pipe but through perforations made laterally at or near the lower end of this pipe. These perforations split up the air and prevent waste through large bubbles which cause slippage.

Perforated foot pieces are now used in all air lift systems in order to effect economy in the use of air, as in fact the air required is only that which is sufficient to keep the discharge column of air and water moving upward in a steady flow.

Figure 3 shows the various methods of piping wells when using either of these two systems described. The two outer methods of piping marked Fig. 1 and Fig. 4 (in Figure 3) are the Pohle systems, and the two central ones, Fig. 2 and Fig. 3 (in Figure 3) the Saunders system. Fig. 4 (in Figure 3) shows a well piped by what is known as the central pipe plan, which instead of admitting the air pipe alongside the water pipe admits it through the center to a point near the bottom of the discharge pipe, the air being admitted by simply cutting a hole in the side

of the pipe. Fig. 2 (in Figure 3) shows a well piped by the Saunders system with a cast iron chamber placed at the bottom of the discharge pipe, the air being admitted on the outside of this pipe and into the chamber near the bottom of the well.

Fig. 3 (in Figure 3) shows this system where the well casing itself serves as an air chamber, the compressed air pipe entering at the top or near the surface of the ground.

ARRANGEMENT OF WELLS AND PIPING.

Proper piping up of wells is a feature counting largely in the success of an Air Lift system, whether working one or several scattered wells. The introduction of unnecessary valves, elbows, angles and bends will cause a loss of air pressure, cut down the efficiency of the plant very largely, and should be avoided as far as possible.

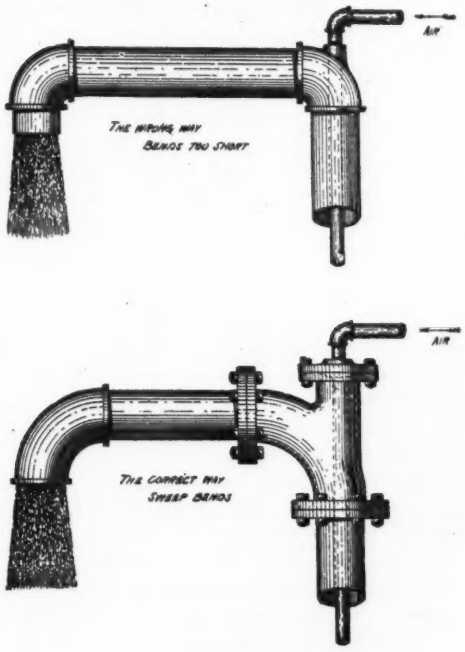


FIG. 4.

It is therefore well to lay out beforehand the wells and piping, placing the wells and reservoir so that pipes can be run direct, with the fewest possible bends, elbows and valves. Pipes should all be made of a size sufficient to carry air to the wells and the water away with the least practical resistance.

The tables available afford a means of determining the sizes of pipes necessary to transmit a given volume of free air with a predetermined drop, or conversely, the reduction of pressure which will occur in a given length where a certain size pipe is used. To the actual lengths, as measured from plans, or on the ground, should be added the increase or allowance for valves, tees and elbows, as given in the tables. It is for this reason that the use of long sweep elbows and tees is recommended, especially for water. In many cases elbows can be avoided by making long bends of pipes. If this is done, the bends should be made smooth, regular and free from dents or kinks.

Figs. 5 and 6, showing typical air lift pumps installed in wells, illustrate clearly the method of piping.

Fig. 5 shows a Class "VA" pump discharging directly into a concrete basin set over the well. From this basin the water either flows by gravity to its destination or is pumped to a stand pipe or storage tank. The deflector or "umbrella" head piece will be noted; this deflector causes the water to flow along natural lines, minimizes resistance and results in increased efficiency; it can be supplied for either the Class "VA" or "VC" pumps in standard sizes for pipe up to 8-inch diameter and in special sizes to any diameter.

Fig. 6 shows a Class "VC" pump designed to discharge into a tank some distance from the well, the 90-degree head piece shown has a long sweeping bend, and can be supplied for any size well desired.

Fig. 7 shows a special adaptation of the central air pipe system. In this type the air and water are mixed in a "mixing chamber" at relatively low velocity, from this they enter the eduction pipe through a reducing nipple which increases the velocity to that for which the pump was designed. After leaving the well the water passes off through pipe B, the air escaping through pipe A. The air from pipe A is sometimes piped back to the compressor intake so as to take advantage of its low temperature.

As the air pressure required with an air lift pump depends upon the submergence, it follows that the starting pressure is higher than the running pressure. In some wells the difference between the static and pumping heads may be sufficiently great to make the starting pressure so much higher than the running pressure as to seriously overload the

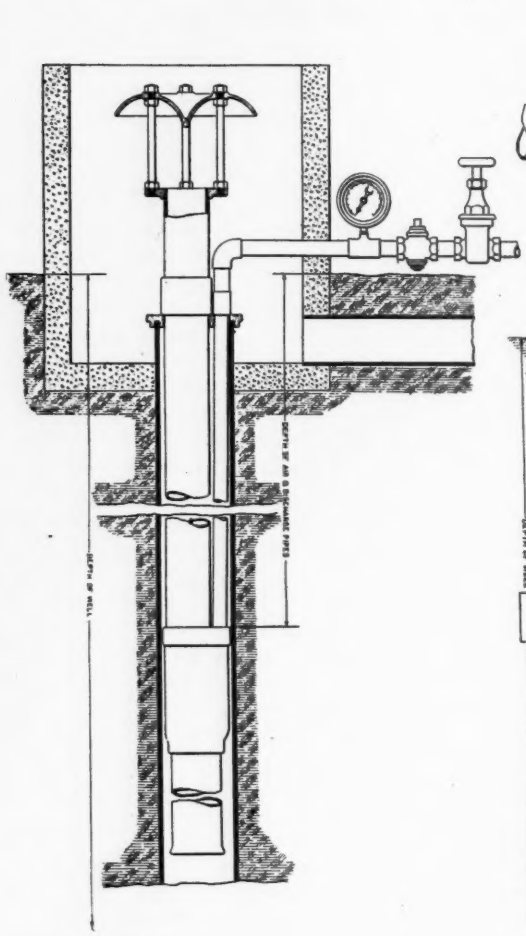


FIG. 5.

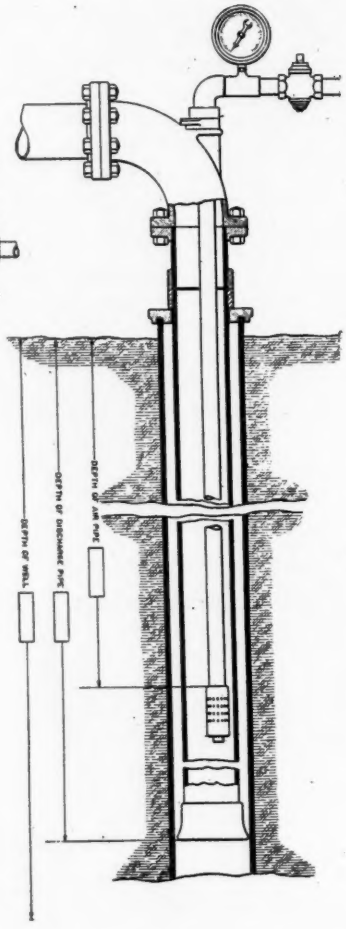


FIG. 6.

air compressor. Air compressors are designed for maximum economy at the average air pressure which, in an air lift pump, remains constant while the pump is in operation, the capacity for overload is limited and it is dangerous to exceed the limit. In Fig. 8 is shown an arrangement known as the compound air lift which will overcome this difficulty. It consists of a standard air lift pump with a special auxiliary or starting pump placed so that its submergence, with respect to the static head, will be such as to utilize the maximum pressure which the compressor is capable of without dangerous overload. When starting a well the air is first turned on to the auxiliary pump and, as the head lowers, the standard pump comes into action and the auxiliary pump is gradually turned off. This arrangement is of course special and requires special engineering.

REGULATION OF AIR SUPPLY.

When running several wells together which require different air pressures, engineers sometimes put throttle valves on all the wells and in regulating them too finely raise the receiver pressure to a point far above that required to run the highest pressure well. All this excess pressure represents power thrown away, and the practice should not be allowed. It is in such cases necessary to have throttle valves in all the low pressure wells and to often have them nearly shut, but the well that requires the highest pressure to operate it should be run with the valve wide open, or

nearly so, and then the other wells regulated to take what air they need, forcing the rest of it to the high pressure well.

An orinary globe valve proves to be the best regulating valve except for very high pressures. Gate valves or plug cocks cannot be regulated as closely and cannot be so readily set at the same point after having been closed. A second globe valve may be used for stopping and starting, thus leaving the economical adjustment of the regulating valve undisturbed.

The brief descriptions just given call attention to a few working combinations, but by no means exhaust the arrangements which can be made. They will suffice, however, to illustrate the wide applicability of this means of raising water.

CONSIDER FUTURE DEVELOPMENTS.

In certain districts, where the water level is continually falling, it is advisable to install higher pressure equipment than would otherwise be required, so as to care for the greater air pressure necessary for the constantly increasing lift.

Economy is the most important factor when considering the installation of an air lift plant. Air compressors may be had to compress air as high as 100 pounds in a single stage, but in order to realize the greatest possible economy two stage compression should be resorted to for all pressures over 70 pounds, while in cases where the pressure is liable to increase, due to the falling water level, two stage compression should be used for pressures as low as 60 pounds. The greater operating economy easily offsets any slight increase in first cost.

In order to check the slippage of pump, a test was run on the reservoir with the wells alone, stopping the pump.

Time of test, minutes.....15
Water lift in reservoir increased, inches..16
Gallons pumped per minute.....3666
Size of compressor used—

Steam cylinder, 20 & 34 ins.
Air cylinder, 32¼ & 21¼ ins.
Stroke of all cylinders, 27 ins.

Cu. ft. displacement in compressor per revolution 23.77
Average revolution per minute..... 66.6
Cu. ft. free air per minute displacement. 1583

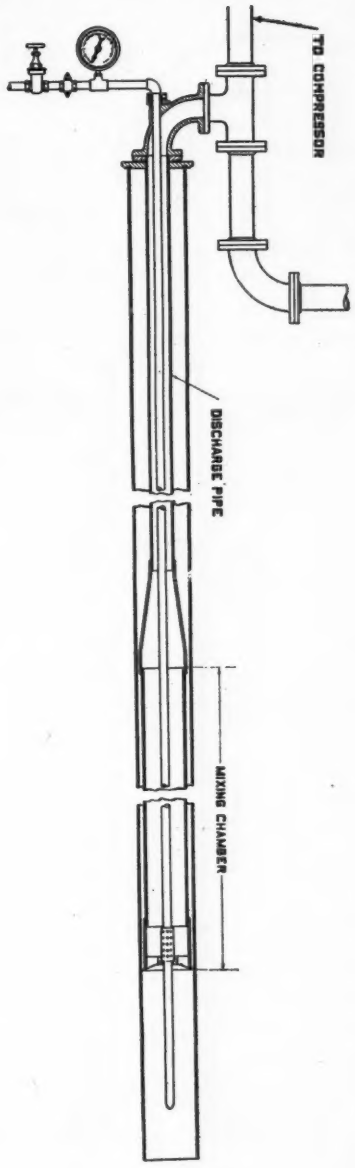


FIG. 7.

3666 gallons per minute lifted 89.5 feet equals 82.85 W-H. P.

W-H. P. divided by I-H. P. equals 39.26 per cent. efficiency.

The simplicity of the air lift system is seen in the fact that the entire plant required is an air compressor with any driving means and an air receiver from which the com-

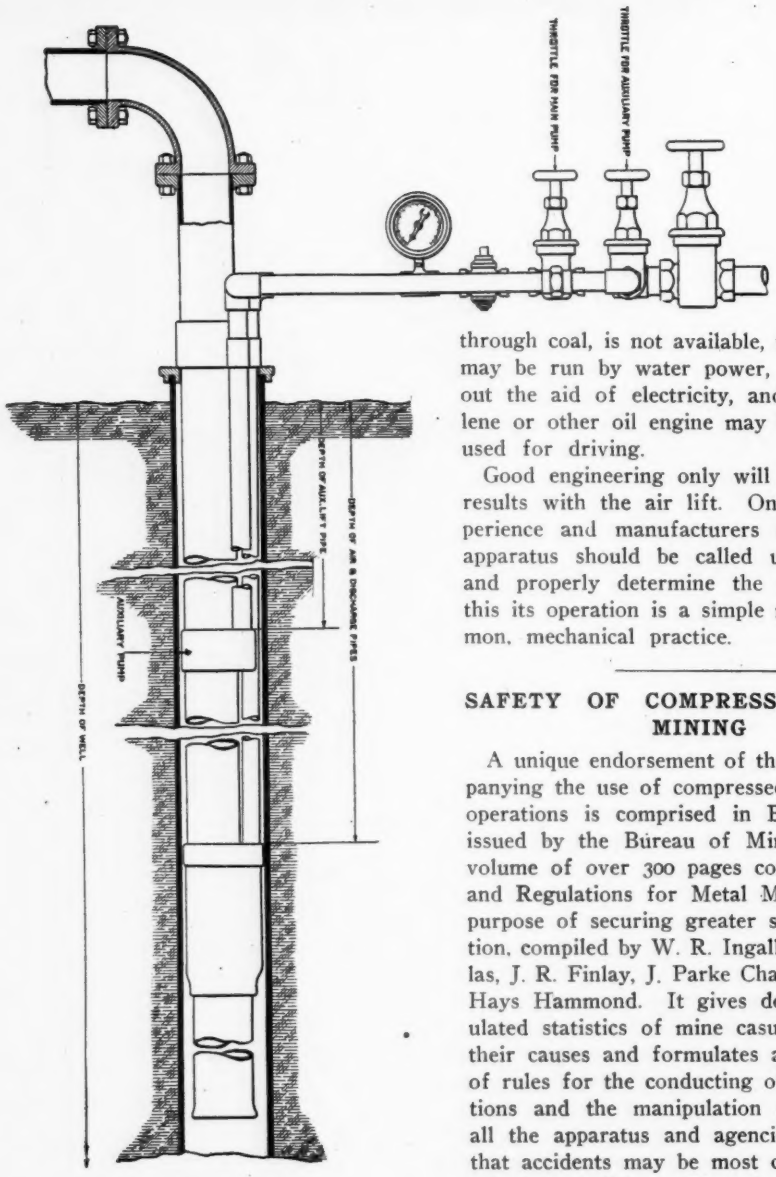

THROTTLE FOR MAIN PUMP
THROTTLE FOR AUXILIARY PUMP
DEPTH OF AUX. LIFT PIPE
DEPTH OF AIR & DISCHARGE PIPES
AUXILIARY PUMP
DEPTH OF WELL

FIG. 8.

pressed air is led to the well in the ground. The only other apparatus is the piping. In some cases special foot-pieces are used, but they are simple castings or tubes.

It is thought that this system should appeal specially to Latin American countries because of the fact that where steam power, through coal, is not available, the compressor may be run by water power, with or without the aid of electricity, and also a gasolene or other oil engine may be successfully used for driving.

Good engineering only will bring the best results with the air lift. Only men of experience and manufacturers of high grade apparatus should be called upon to advise and properly determine the details. After this its operation is a simple matter of common, mechanical practice.

SAFETY OF COMPRESSED AIR IN MINING

A unique endorsement of the safety accompanying the use of compressed air in mining operations is comprised in Bulletin 75 just issued by the Bureau of Mines. This is a volume of over 300 pages containing "Rules and Regulations for Metal Mines," with the purpose of securing greater safety of operation, compiled by W. R. Ingalls, James Douglas, J. R. Finlay, J. Parke Channing and John Hays Hammond. It gives detailed and tabulated statistics of mine casualties, discusses their causes and formulates a complete code of rules for the conducting of mining operations and the manipulation and control of all the apparatus and agencies employed so that accidents may be most completely minimized or abolished. There is but one requirement noted concerning compressed air, which is that all air receivers shall be submitted to a pressure test 50 per cent. above the maximum pressure to be carried, and that they shall be regularly drained or blown off. The index of the book contains 52 page number references to the requirements regarding electrical equipment.

REPORT OF TESTS AT PLAINFIELD, N. J.

Number of well	3	4	5	6	8	9	10	11
Depth, feet	350	400	350	300	304	350	350	350
Length of discharge(100%)	204	204	203	204	210	217	205	213
Starting pressure, lbs.	66	60	60	65	65	65	65	65
Running pressure, lbs.	59	55	55	57	56	60	54	55
Shut in pressure, lbs.	53	51	50	54	51	54	48	50
Submergence, per cent.	60	57.5	56.5	61	56	57	53.5	54
Submergence, feet	122	117	115	124	117	124	110	115
Lift, feet	82	87	88	80	93	93	95	98
Free air constant	.400	.432	.440	.387	.462	.447	.485	.489

Average submergence....118
Average percentage of submergence....57
Average lift, feet....89.5
Average constant....443

GENERAL AIR LIFT DATA.

Time, A. M.	10:05	10:20	10:35	10:50	11:05
Compressor, r. p. m.	67	67	67	67	65
Working pressure	69	69	69	69	68
Water lift reservoir, ins.	30⅝	31⅝	30	33⅞	32¼
Steam pressure	115	109	114	114	104

Average revolution of compressor per minute....66.6
Average working pressure....68.8
Revolution of pump in one hour....1818
Size of duplex pump cylinders....20½ x 24-inch stroke
Gallons per revolution....137.2
Gallons pumped in one hour....249,429.6
Gallons pumped per minute (displacement)....4157.1
Estimate slippage, 10 per cent....415
Actual gallons pumped per minute....3742
Size of reservoir....250 x 22 feet
Gallons in reservoir per inch....2437.5
Loss in reservoir in one hour....1⅝ inches
Loss in reservoir in gallons....5586.5
Loss in reservoir per minute....93.1
Actual gallons pumped per minute....3649

AUTOMATIC PNEUMATIC APPARATUS FOR TRANSFERRING LIQUIDS

The following interesting description of an ingenious and practically successful device we reproduce, somewhat abridged, from Metallurgical and Chemical Engineering, Dec. 1, 1915.

In making use of compressed air power for handling liquids, it is necessary to have a blow-case or air-tight chamber into which the liquid is admitted (usually by gravity), and from which it is forced to its destination by the compressed air, the latter being also admitted to the blow-case at necessary intervals. The process consists, therefore, in admitting liquid until the blow-case is filled, then turning off the liquid and turning on an air valve which admits the air. This operation is repeated continuously as long as liquid is to be lifted.

THE AUTOMATIC FEATURE.

It has long been the effort of inventors to obtain an automatic device which will turn on and off the valves necessary for this operation, and a number of apparatus have from time to time appeared which have been claimed to accomplish this purpose. The chief objection, however, to these apparatus has always been their complicated construction, allowing too great an opportunity for trouble in the mechanical operation.

The latest of these devices, known as the Bihn-Jones automatic air device, seems to have overcome all these objections and is very simple in construction and operation. The apparatus consists of two parts. The first is an any-position check valve which is composed of two essential parts, namely, a body which contains the valve seat and a flapper which swings on trunnions, thus constituting a valve which will operate in any position. The second piece of apparatus is the automatic air device proper. It is composed, first, of a body in which is formed the seat of the valve, through which the ports for the admission of compressed air open, the upper portion of the body also containing the exhaust port. Secondly, a disk of a cone and piston type is provided which has two seats, at the bottom a cone which closes the compressed-air ports and at the top a flat seat which closes the exhaust port. These devices are illustrated in Figs. 1 and 2 respectively.

DETAILED ACTION OF DEVICE.

Parts of Air Device.—The air device consists of the following parts:

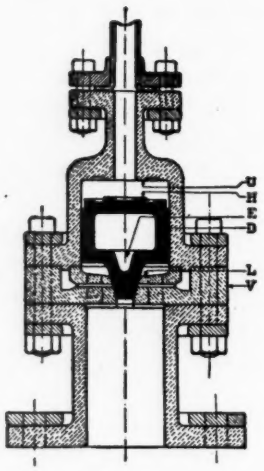


FIG. 1.

1. Valve body *V*, which contains a seat *L* controlling the ports for the admission of compressed air, and a seat *U* for controlling the exhaust ports.

2. Disk *D*, of the cone and piston type, the cone *E* being at the base and completes the compressed-air valve. At the top of the Disk *D* is a seat *H*, which completes the exhaust-air valve.

The device is actuated by the liquid from storage tank *A*, which flows through the check

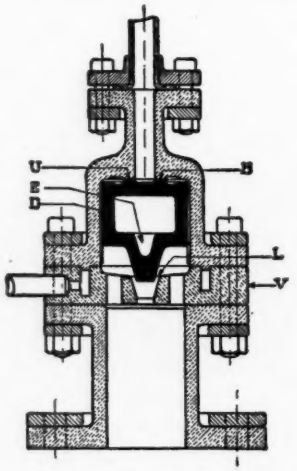


FIG. 2.

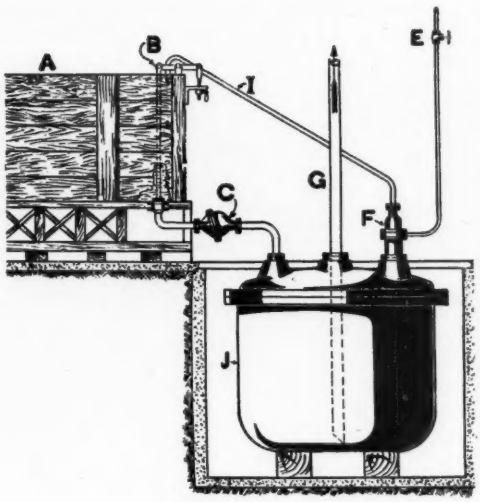


FIG. 3.

valve *C* into the blow-case *J*. This liquid rises until it reaches the cone of the disk *D* of the automatic-air device *F*, which it raises, thus permitting compressed air to enter.

The sudden release of the compressed air forces the disk *D* upward against its upper seat *U*, thus closing the exhaust port to vent pipe *I*.

The air pressure is thus prevented from escaping and the pressure exerted on top of the liquid closes the check valve *C* and forces the liquid through discharge pipe *G* to its destination.

When the level of the liquid reaches the opening of the discharge pipe at bottom of blow-case, the compressed air rushes out with the liquid, thus clearing the discharge pipe. The result of the air rushing out the discharge pipe causes a considerable drop of pressure within the blow-case, thus allowing the disk *D* of the air device to drop to its lower seat *L* due to its own weight, simultaneously cutting off the supply of compressed air and opening the exhaust port.

The check valve *C* in the supply line has remained closed during the emptying of the blow-case, but immediately upon the reduction of pressure within the blow-case the check valve opens (due to the head of the liquid in the supply line) and allows the blow-case to refill.

The free air or gas from liquid displaced from blow-case due to refilling is discharged to atmosphere through vent *I*.

The flow of liquid from tank to blow-case may be regulated by a plunger and thumb screw arrangement, as shown at *B* in Fig. 3, or by means of a stop valve. Accordingly, by regulating the supply, the contents of blow-case may be automatically discharged in any specified time.

It will be noticed from the above illustration that the apparatus is entirely outside of the blow-case, no part of it extending within the same, but resting upon a flange collar above the case. It can therefore be readily removed for examination, and its ease of operation may be readily understood.

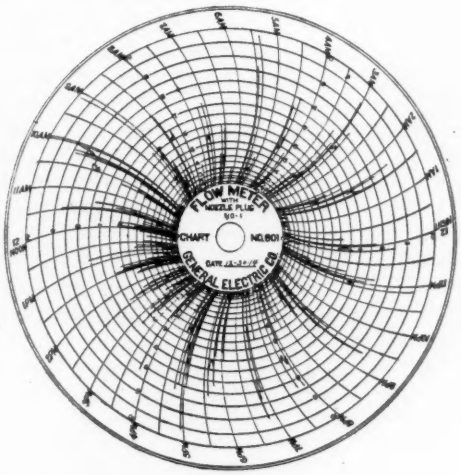


FIG. 4.

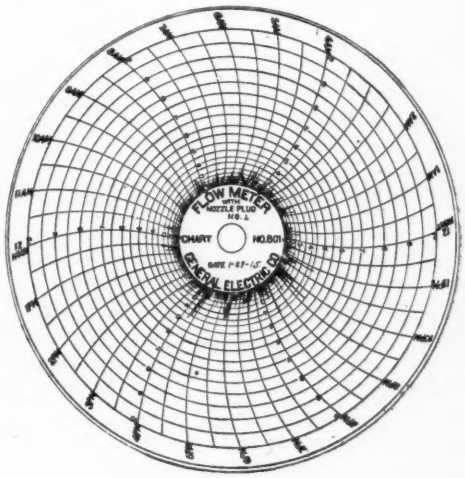


FIG. 5.

THE SAVING OF AIR AND POWER.

Aside from being entirely automatic in operation and simple in construction, this device is claimed to reduce considerably the consumption of compressed air which is known to be quite expensive. The charts, Fig. 4 and Fig. 5, were made in a plant where forty blow-cases are in use, seven of which were equipped with the Bihn-Jones automatic air device at the time the test was made. The heavy irregular lines indicate the exact travel of the needle, which indicate the comparative consumption of compressed air. Fig. 4 was produced when the blow-cases were operated by hand, that is, compressed air turned on and off each time the blow-case was discharged, while Fig. 5 illustrates the consumption of air by the seven blow-cases which were equipped with the Bihn-Jones device.

The saving in compressed air is further illustrated by the fact that in the above-mentioned case, in which the forty blow-cases, of 3 to 5½ tons capacity, are being filled and discharged continuously day and night, after the installation of the seven Bihn-Jones automatic air devices one of the compressors was shut down and has since been kept as a reserve unit.

This device is claimed to be particularly adaptable to conditions wherein large bulks of liquids are to be handled, and by properly selecting the material from which it is made it will handle with equal efficiency corrosive material, oily liquids, and, in fact, any material which may be readily caused to flow by compressed air. Its most extensive application is found in handling of sulphuric acid in fertilizer and acid manufacturing plants.

The device is being manufactured by The Schutte & Koerting Company of Philadelphia, Pa.

AIR PRESSURE FOR AUTOMOBILE TIRES

In a paper before the Society of Automobile Engineers, Mr. P. W. Litchfield, factory manager of the Goodyear Tire and Rubber Company, estimated the annual cost of tires in this country at $192,000,000 and further showed that at least 30 per cent of this, or $57,600,000, is wasted by improper loading and inadequate inflation. The following self-explanatory table of pressures and permissible loads per tire was presented.

GROSS LOAD, POUNDS PER TIRE, INCLUDING PASSENGERS AND COMPLETE EQUIPMENT

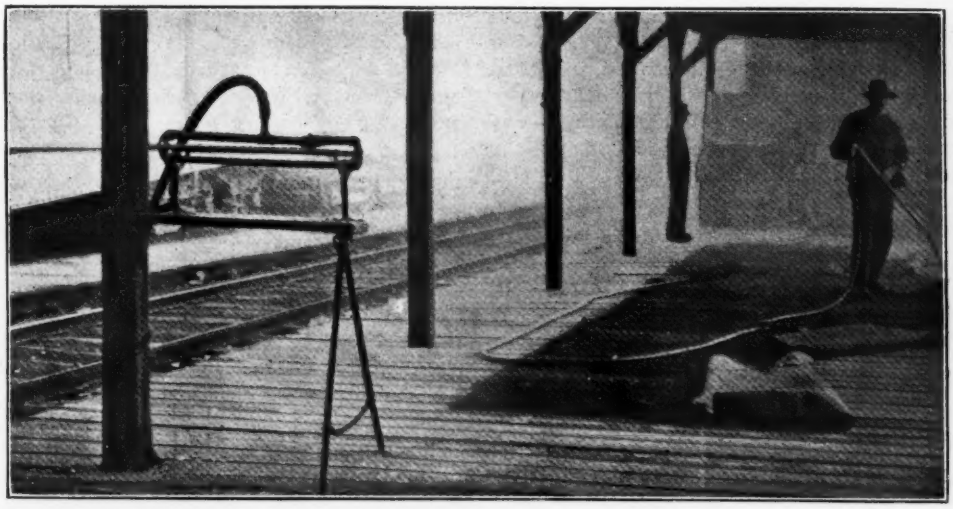
Inflation Pressure, Lbs.	Tire Section Diameter							
	3 in.	3½ in.	4 in.	4½ in.	5 in.	5½ in.	6 in.
30	250						
35	290	360					
40	335	410	500				
45	375	460	560	675			
50	415	515	625	750	875	1000	1140
55	460	565	690	825	960	1100	1255
60	500	615	750	900	1050	1200	1370
65		670	815	975	1135	1300	1480
70		720	875	1050	1225	1400	1595
75			940	1125	1310	1500	1710
80			1000	1200	1400	1600	1925
85				1275	1485	1700	1940
90				1350	1570	1800	2050
95					1660	1900	2165
100						2000	2280

Long experience has shown, says Mr. Litchfield, that these loads and air pressures are the most satisfactory combination for maximum service and effective cushioning. The qualities of comfort and easy riding must be recognized as vital points, equally as important as tire durability. Why are pneumatic tires used at all if not for easy riding?

The degree to which a tire is flattened against the ground varies with the load. For every given tire load there is a definite percentage of tire deflection which bears a direct relation to the inflation pressure. Obviously, then, a scale of relative carrying capacities and inflation pressures, if properly observed, will tend to eliminate the enormous waste now caused by haphazard methods of loading and inflating.

The load properly assigned to a tire should be the actual load on the tire with the car fully loaded. The actual load on each tire can be ascertained by weighing first the front of the fully loaded car, then the rear, dividing each figure by 2 to get the load per tire. It can then be inflated to the proper pressure for that particular weight as indicated by the scale of carrying capacities and

inflation pressure. A certain tolerance in pressure should be allowed for leakage, but before the pressure drops 20 per cent the tire should be pumped up again.



CLEANING CARPETS AT RAILROAD TERMINALS

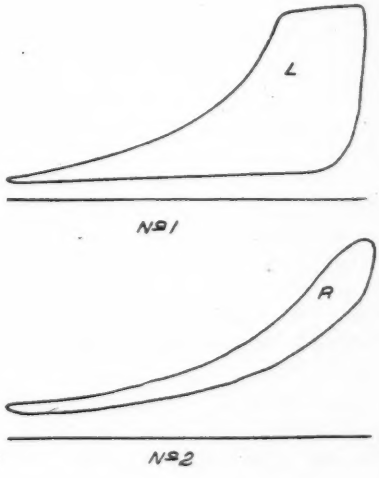
The method of cleaning carpets at the car yards of the Chicago & Western Indiana, a terminal company at Chicago, is shown in the illustration. Compressed air is used. The arrangement shown at the left is for cleaning or blowing the dirt out of the aisle strips. It consists of two guide rods and a pipe with perforations on its under side. The carpet is passed over one guide rod, under the perforated pipe and out over the other guide rod. The arrangement is simple and cleans the aisle strips thoroughly. The method of cleaning the larger pieces of carpet is shown at the right. Air from the shop line is used in both cases, the water being thoroughly blown out of the apparatus and pipes before using.—*Railway Age Gazette.*

DISCHARGE VALVE TROUBLE IN AMMONIA COMPRESSOR

The cut here reproduced from *Practical Engineer* shows two indicator cards from an Ammonia Compressor which tell a very clear story. An ice plant which had been running several years was producing less refrigeration than usual, showing that something was wrong. The trouble was thought to be in the compressor, which had duplex, single acting compressor cylinders, as one ran warmer than the other, although the same amount of cooling water was used on each.

Diagram No. 1 was taken from the left hand cylinder, and as this was thought to be fairly good, No. 2 was taken from the right hand cylinder. This showed at once that this cylinder was doing very little work, and that the trouble was principally with the discharge valves.

The machine could not be spared very long



at a time, writes Mr. J. C. Hawkins, and we decided to examine the springs and discharge valves on the defective side. After getting the cylinder open, we found one valve spring broken, and all the discharge valves were badly gummed up with a putty-like substance of grease and scale. The valves and springs were washed with coal oil, and a new spring put in place of the broken one. After the machine was started, the indicator was applied again and a diagram similar to No. 1 taken.

From the conditions found in this cylinder it was decided to open the other compressor at the first opportunity, for the purpose of examination, and cleaning out the valves. After overhauling the machine the output of ice was increased to its regular amount.

If the machine is to do good work, the discharge valves must be examined occasionally, as a slight leakage back through the valves will greatly decrease the output of the compressor. The spongy substance in the cylinders was thought to have been due to the use of a poor grade of ammonia oil in the compressor, which was being used at that time on account of its low price. Changing to another grade of oil helped to prevent further trouble from valves sticking.

NEW LIQUID AIR BLASTING PROCESS*

The first equipment with liquid air as an explosive dates back nearly to the beginning of its industrial production. Professor von Linde made an explosive called "Oxyliquit" by mixing liquid air with charcoal. This explosive broth, or paste, was put directly into the drill hole and fired by means of cartridges and fuses.

Since this primitive method gave unsatisfactory results, it was modified by filling a suitably prepared cardboard cylinder with an explosive substance, preferably by dipping the whole in liquid air. This method gave results, but was lacking in safety and depended on the skill of the workmen and quickness of manipulation. The trouble was due largely to the enormous difference in temperature between the liquid air and the surrounding rock, so that the air rapidly evaporated in the hole. The maximum theoretical life of a blasting cartridge was thus only 10 min., while in practice it was still shorter.

Interesting experiments have been made in France by Georges Claude, and other experiments which improve upon the von Linde method have been conducted in Charlottenburg, Germany, by Kowatsch, with the coöperation of von Baldus.

In order to prevent a rapid evaporation of the liquid air, Kowatsch puts the cartridge with the dry carbon container in the drill hole before introducing the liquid air and avoids the dangerous loss of time by necessary preparations, such as tamping the hole after the mixture has been made. The liquid air is not introduced until time for shotfiring. This reduces the evaporation period to a minimum.

The cardboard cylinder contains a perforated partition tube in which is placed a perfectly innocuous mixture of infusorial earth and oil or asphalt, or of soot and paraffin. The central partition tube incloses a cardboard tube, over which is thrust another cardboard tube to serve for carrying off the evaporation product of the liquid air. If several holes are to be fired at once, the electric wires are connected.

The liquid air intended for each hole is provided in a suitable quantity in a small flask to the opening of which is attached a metal tube with a conical point, into which tube is introduced the central tube of the cartridge. To charge the cartridge, it suffices to raise the back end of the flask. The liquid air is then lifted by pressure of its evaporation products (just as water containing gas is lifted by pressure of carbonic acid) in the metal tube and is forced into the cartridge. At the moment when the shot is fired by an electric fuse, the liquid air combines with the components of the charge and causes an explosion of extraordinary energy.

---

*From an article by M. Pryzborski, mining inspector, Budapest, Hungary, in the *Montanistische Rundschau.*

The volume of the saline matter in the ocean is somewhat more than 265,956,133,600,000 cu. ft., according to the United States Geological Survey, or enough to cover the entire surface of the United States, excluding Alaska, 8,448 ft. deep, or more than a mile and a half.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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CONTENTS

Bypass Around Leaky Tunnel..... 7843
Lining a Tunnel by Compressed Air... 7847
Deep Diving Record 7848
War Consumption of Metals..... 7848
Dynamite Ditch Digging..... 7848
Edison Wireless Telegraphy..... 7849
Air Tests the Fineness of Cement..... 7850
Lifting Water by Compressed Air.... 7850
Safety of Compressed Air in Mining.... 7858
Pneumatic Transfer of Liquids..... 7860
Air Pressure for Automobile Tires.... 7862
Cleaning Carpets for Railroads..... 7863
Valve Trouble in Ammonia Compressor. 7863
New Liquid Air Blasting Process..... 7864
New Year Optimism 7865
Freezing of Air Pipes in Winter..... 7866
Compressed Air Tunnel Ventilation.... 7867
Handling Drill Steel 7868
Lung Motors 7869
Notes 7869
Patents 7871

NEW YEAR OPTIMISM

The final page is filled, the book is closed
Which holds the record of the buried year;
And such a year may earth ne'er see again,
As surely never was the like before,
What times are these in which we find ourselves,
Or who had dared to prophecy of what
So suddenly has come upon us?
Cajoled by soothing sophistries, we thought
And talked of peace as though nought else could be.
Of comfortable toil and honest gain
We had our wonted schemes, and while we wrought
There burst a storm unparalleled and full
Of crashing devastation, death and woe.
It seems that all the arts so full of good,
Which made this later age so rich and fat,
Can still be used as well for purposes
Most devilish. So while we piled our gains,
And gloried in the increase of our wealth,
Grim war was learning also of new ways
To kill, was stacking up his projectiles.
His ammunition and his guns of strength
To strike afar.

Most curious it is
That agencies beneficent, and rich
In most desired accomplishment, are just
The things which make the pungency of war,
The high explosives rend the rocks and cut
The channels which convey from mountain lake
To thirsty city health and strength, or spread
The waters over sun-parched plains, and make
The wilderness to yield us grain and fruit.
These giant helpers pierce the hills and make
The paths of trade and pleasure smooth and straight,
And distance is forgot. They make the deeper rocks
To yield us coal and iron, metallic stores
For varied industry, and gold which men
Do strive for evermore.

Now so it is
That strength Herculean is none the less
When turned to tasks sinister. Modern war
Had never been but for what peace has taught,
And only by the means which peace provides.
Success could e'er be thought of. Fighting now

May be on land or sea, or in the sky,
Or in dark waters 'neath the wave and none
Is satisfied or safe to fight without
Explosives of the sharpest. Armed with these
Commensurate accomplishment is sure
As in the ways of peace.

But after all
A great automaton, too great, too slow,
For individual human kin to scan,
Is this old world of ours. She has a way
To set things right, so right that all shall see
And know them to be better than before,
The ways of prosperous peace may sometimes need
Correction, but for war the end is sure.
The winning one is peace, the loser war;
No constant loser can keep up the game,
And when the stakes are gone it must take long
To get the means and will to play again.
And so we live in certainty of peace
For long enduring years when this great storm
Has spent its force. Preparedness is well,
But first, and without haste, we have to find
What 'tis we must prepare for. R.

THE FREEZING OF AIR PIPES IN WINTER

BY FRANK RICHARDS.

The following inquiry recently received should be of interest to others besides the writer:

"I have air traveling through a 4-in. pipe on the surface of the ground about 2000 ft. and I expect to work this winter. How can I prevent the air from freezing? Will glycerin dropped into the pipe, say ½ pt. per day, prevent it from freezing? Shall I cover it with box and manure? At what temperature is it likely to freeze? How much circulation must air have to prevent freezing?"

This is an interesting series of questions and all to the point, also pertinent to the approaching season. In replying, it should first be remarked that, as our correspondent of course knows, it is not the air that freezes and makes the trouble, but the water which the air carries, and not all of that. Atmospheric air normally always contains intimately distributed through it, a variable proportion of water, and the ability to carry more and more, or to hold more securely what it already contains, comes with increase of temperature. When air is compressed with little or no cooling during the compressing operation, as it generally is even if the cylinders are water-jacketed, it is delivered at a considerably increased temperature, and so long as the heated condition continues there can be no deposition of water, which is why water is not deposited in an air receiver located near the compressor.

As the air flows along through a pipe line, however, it cools very rapidly, and in a run of 2000 ft., as above, it would certainly be cooled nearly to the temperature of its surroundings. If the air has been compressed to a pressure of, say, 6 atmospheres, or 75 lb. gage pressure, its capacity for moisture is reduced, for corresponding temperatures, to about ⅙ of that of the free air, with which it started; consequently, as it has flowed along through the pipe and has gradually cooled, it has been giving up its moisture to collect and flow along the bottom of the pipe.

Now, if it happened to be freezing weather and the pipe was cooled to below the freezing point, the water thus flowing within it would certainly freeze there, and keep on freezing layer upon layer, until the pipe might be completely choked by the accumulated ice. The only thing to do under these conditions is to protect the pipe so that its contents will not freeze. This, of course, may be done by covering it with sufficient protective material or by burying it in the ground to a sufficient depth, the same as a water pipe. Means should be provided for drawing off the water at low points; if there were alternating periods of freezing and thawing, the latter should be taken advantage of for draining, although the thawing would probably be slow after the ice was once formed.

It is good practice, and it will pay for itself in most cases, to provide an efficient aftercooler near the compressor, and in connection with that a separtor to take care of the water; any good steam separator would do, and the latter, taking the air when it was at its highest pressure and at its lowest temperature, both conditions minimizing the capacity of the air for moisture, should leave little or no water to be carried along into the pipe line.

As to how much circulation the air must have to prevent freezing; this would have

little to do with it, and the greater the volume of air the greater also would be the quantity of water carried by it and ready to be deposited and frozen if the other conditions concurred.—*Practical Engineer.*

THE FIRST COMPRESSED AIR TUNNEL VENTILATION

BY F. M. PIERCE.

In the mammoth workings of the famous Comstock Lode, at Virginia City, Nev., were initiated many of the practices that have been developel into systems. The nature of the rock in that locality and the great depth of the workings generated extreme temperatures when the rock was exposed to the air. This made it necessary to introduce quickly into the faces of the extreme workings fresh, cold air in sufficient volume to sustain the almost naked and sweat-smothered miners working in short shifts or reliefs.

Power rock drills driven by compressed air were first extensively used in mining and tunneling in the Comstock Lode. True, such machines had been employed in the Hoosac Tunnel in Massachusetts and in another driven in Pennsylvania, but they were so heavy and cumbersome, requiring ponderous carriages for their mounting, and mechanically were so defective that as economical factors in tunneling they had given little if any advantage over hand drilling. Later they were modified and made more adaptable, and their practical worth was first demonstrated in the Sutro Tunnel driven to tap the Comstock Lode at depth to drain it of water and permit transportation of the ores to the mills near the tunnel's mouth.

Smaller machine drills adapted to the mine drifts came to be quite generally used in the workings of that lode, and the compressed air with which they were driven, exhausting from them into the extreme headings and expanding to four or five times its volume and thus being rendered very cold, supplied the miners with ample fresh, cold air and a ready and admirable means of ventilating the workings.

From this Comstock Lode practice has developed the system of tunnel ventilation by compressed air now generally employed. But its growth was slow and round-about. In fact the resumption of this local practice with compressed air and its development in large tunnel work were taken up many years later, after steam exhausted from power drills had proved to be more or less a success in such work.

Steam-exhaust ventilation was first demonstrated by a Colorado miner whose name I do not recall. With one power drill driven by steam, he ran a small mine tunnel 1,000 ft. into a mountain and ventilated it by utilizing the exhaust steam from his machine in the following manner:

Near his steam boiler, at the mouth of the tunnel, he set up a wooden box chimney connected at the bottom to a similar horizontal box which ran in near the face of the heading. Into the end of this flue he set up a wide-mouthed funnel, which was removed before blasting. By opening a ¼-in. steam jet in the chimney after a blast, he caused a strong suction to draw the foul air into the inner end of his ventilating box. This in no long time so cleared the extreme heading that he went in, set up his funnel and machine and went to drilling, carrying the exhaust steam through a hose into the funnel. The exhaust was sufficient to maintain the draft, and the live-steam jet in the chimney was shut off. This device kept his tunnel filled with a flow of fresh air and his heading comfortably cool. This worthy adventurer took righteous pleasure in writing me of his success with steam against my expressed belief that he could not make it work successfully in tunneling.

Years later, on one of the several railway tunnels that were undertaken on the South Penn Ry. to run between Harrisburg and Pittsburgh, the contractors started using steam for driving the drills until air compressors could be built and installed. On getting in a distance, the steam from the machines uncomfortably raised the temperature. The Colorado miner's device recurred to my mind, and it was introduced, where some seven drills were in operation. It ventilated the tunnel while it was being driven in some 800 ft.

Years after the South Penn work the Croton Aqueduct Tunnel for the supply of water to New York City was under way. This 36 mile tunnel was the longest that had ever been undertaken. In the center of every 3,000 ft. section a shaft was sunk to grade, and tunnels were driven north and south from this,

each 1,500 ft., until they met opposite headings. Extensive ventilation was unnecessary, and this was foreseen to be very expensive unless some method other than by the usual exhaust fans or blowers could be devised.

I had equipped half of the tunnel, under contract with Brown, Howard & Co., with Ingersoll drills, air compressors, boilers, etc., and was in constant consultation with D. D. McBean, of that firm, the manager of the work. When the matter of ventilation came up, Mr. McBean was in no way disposed to go into the large expense of equipment with known appliances if this could be obviated—and he was not the man to permit difficulties of any nature to prevent the employment of simple and effective means. On his hearing of the success of compressed air in the Comstock heading and steam exhaust in the Colorado mine and the South Penn Ry. tunnel, he decided to try them in his work on the Croton Aqueduct Tunnel. They were successfully adapted. This was the first development and use of the since well-known system of compressed air ventilation for large tunneling operations. The features of this system and its details have become too well known to warrant mention here.

Up to that time, as president of the Ingersoll Rock Drill Co., I had furnished the mechanical equipment for seven-eighths of the railway and other large tunnels that had been made using power drills, and was therefore in a position to know what appliances had been tried or used. To the best of my knowledge this is the history of the rise and development of this system of tunnel ventilation. —*Engineering News.*

HANDLING DRILL-STEEL

BY P. B. MCDONALD.

The old method of handling drill-steel at a mine, namely, getting the dull steel to the sharpening-shop on surface and the sharp steel to the miners underground, was careless. As little attention as possible was spared for this purpose. In some cases, each miner carried his dull steel to the shaft when he went up at half-shift, took the bundle up on the cage, and carried it to the blacksmith-shop; the sharpened steel he carried back in the same manner.

There are many objections to this primitive method:

1. A miner should have as many miscellaneous worries removed from his shoulders as possible; his job is to mine, and he has enough to do if he does that well.

2. It is dangerous for men to crowd into a cage when each has an armful of drills to carry; a stray drill sticking into the shaft may wreck the cage.

3. If the shop is quite a distance from the shaft, as it frequently is, the task of carrying a dozen lengths of drill-steel there, perhaps through snow or rain, is exhausting to a man in wet or thin underground clothes.

4. When a miner has to carry his own steel, he will continue to use dull drills as long as possible rather than change, thus working with poor tools.

Another method of collecting and distributing steel is to have one or more 'drill-boys' make the rounds of the mine, hoisting and lowering the steel without danger of accidents, in much the same manner as 'powder-mongers' distribute explosives underground. There is not so much objection, however, to the miners carrying dull steel to the shaft underground and sharp steel from the shaft to their places of working, so long as that is the limit, because they have to walk in and out to these places anyway. Where the mine has but a one-compartment shaft, it is a good plan to utilize the lunch-hour or any periods of time between shifts to have the drill-steel raised and lowered.

Among the aids to the handling of drill-steel in use at large mines are the following. Wooden racks, either horizontal or vertical, are built on each level near the shaft, where sharp steel is kept always on hand arranged in the different racks according to lengths; then, whenever any miner wants sharp steel he merely carries out his dull drills to the shaft-station and takes back sharp sets; the racks are kept full and the dull steel is taken to surface by a special man or two. To convey the steel between the shaft and the sharpening-shop, horses and wagons can be employed advantageously; one mine has a special wagon-box which is removed at the shop by a traveling-crane and lifted handily to the drill-sharpeners. Another aid to good work by the miners is to keep each contract's or gang's steel separate. Numbers corresponding with the contract are stamped on the shank of each drill, and when sharpened each

contract's drills are packed neatly in a 5-inch iron ring and held there securely with wooden wedges. Miners work to better advantage when they have individual steels.

The practice of constructing a tunnel from just below the collar of the shaft to the sharpening-shop is to be commended. Such tunnels have a narrow-gauge track and push-car, and are lighted by electricity. By the use of them, drill-steel can be unloaded from the cage onto the push-car without distributing operations around the surface of the shaft, which is always a busy place.

Recent improvements in mechanical drill-sharpeners and drill-makers, and the use of special dies for forming new-style bits, such as the Carr, have tended to systematize and improve the sharpening of drill-steel. The assiduous application of the principles of scientific management has indicated the immense importance of properly-designed and correctly-sharpened bits. Drill-steel and bits are seemingly trivial but actually are extremely significant matters. It is the drill-bit that is the critical link between the men and the rock to be removed.—*Mining Press.*

LUNG MOTORS

A new device for the saving of lives in the coal fields of Pennsylvania are the lung motors which are used for the same purposes as the pulmotors of the many trained rescue squads. The lung motors are now in successful use for the resuscitation of victims of drowning, asphyxiation and electric shock, all possibilities in the complex internal economy of a modern mine.

Wherever the natural breathing of the victime of an accident has been arrested, the lung motors have proved invaluable. They weigh about a third as much as a pulmotor and have the advantage that they can be operated by one man. In construction they resemble a bicycle hand pump, but there are check valves on the intake and exhaust. A mask lined with a rubber cushion that can be inflated so as to cut off all outside air when held firmly against the face, is placed over the nose of the victim, and there are instructions on the apparatus itself as to how many strokes a minute to make for victims of different ages from childhood to maternity. The number for an adult is eighteen.

By a mechanical device attached to the foot of the pump the lung motor can be arranged so as to give the victims nothing but air, half air and half oxygen, or all oxygen. When the latter is necessary the oxygen tank from one of the Draeger oxygen helmets with which all rescue squads are equipped can be used.

TOO MUCH FUNNY BUSINESS

The following bulletin recently printed by the Youngstown Sheet and Tube Company fully explains itself:

"We have just had a man badly hurt while engaged in a 'kidding' match. This is not the first instance of the kind that has happened in our works. Wrestling, suffling, horse play, kidding and goosing have no place in any working establishment. Things may be started in all innocence and without intent to cause harm, but too often there is some unforeseen happening that results in a serious or perhaps fatal accident to one or several employees. Cut out the kidding game."

NOTES

Altitude does not affect men wearing mine-rescue apparatus. Four different types were tried at the top of Pikes Peak, Colorado, a height of 14,147 ft., by the U. S. Bureau of Mines at the end of August.

Hard hats should be worn by men working in shafts. At the Woodbury shaft of the Newport mine, Ironwood, Michigan, the miners were supplied with a hat made of felt treated with rosin and shellac. Such hats are hard enough to resist a severe blow.

"Blackboards" made of plate glass have been installed in the classrooms of a Portland, Oregon, school. The writing surface is prepared by a special sand-blast treatment and the back is painted black. It can be readily wiped or washed and is easily kept fresh and clean.

Australian miners are digging for gold in the trenches on Gallipoli Peninsula, says a dispatch to the Chicago *News*. They were surprised at the similarity of the Gallipoli ground to the Australian gold fields, and their sharp eyes soon discovered traces of the yellow metal. In their spare time the miners built rude

placer outfits on the seashore and began washing for gold. They found it, and now the Australian troops with mining experience are passing every minute when not fighting the Turks in washing clay, which is brought to the shore from half a mile inland.

At a certain lumber camp in the northwest it was suggested that a lot of sanitary drinking cups be ordered. "Good idee," said the camp boss, "we'll git some o' thim kind o' cups right away, and while we're about it we'll git a gross o' medicine droppers so's the min kin use 'em to spit on their hands."

It is estimated that 200,000,000 lbs. of copper was required in the manufacture of 50,000,000 shells contracted for in this country since the war began up to October 1. It is also estimated that 94,000,000 lbs. of spelter will be consumed in this manufacture, as well as 346,000,000 lbs. of lead in the loading charge of these projectiles.

Pumping a man full of compressed air is still considered a joke by some people. Besides the case recently reported by the *Journal*, a worker at the Midvale Steel Works in Pennsylvania was subjected by two facetious fellow workmen, to an air hose containing air at a pressure of 80 lb. per sq. in. Immediate injury was not discovered, but soon after the man was suddenly taken ill while at work. At the hospital it was discovered that almost every internal organ had been ruptured by the air pressure, and it is not expected that the man can live. The fool-killer is a long way behind in his work.—*Eng. and Min. Journal.*

The B. F. Sturtevant Company has placed a portable electric warm-air blower on the market. It is offered for more or less temporary heating in a garage; for drying paint and also for drying in dyeing, photographic and blueprint rooms, and for heating rooms used only occasionally. The outfit consists of a small motor-driven fan discharging air through electric heating coils placed in an aluminum casing, the forced circulation being relied upon to give a very large volume of air in a short time. Five different sizes of sets are made and the air is delivered at one, two or three temperatures, depending upon the size. The fan outlet can be turned to discharge in any direction and the switch mounted on the base has different positions to control the temperature of the air delivered.

A remarkable record of continuity of service in power plant operation has been reported by the Quincy Market Cold Storage and Warehouse Company, at Boston. Mr. Fairbanks, the chief engineer of this company, reports that they have had in operation a 500-kilowatt Westinghouse-Parsons turbine that has been carrying load continuously for two years and eight months without the steam being turned off at the throttle. Recently they decided to shut down the turbine to give it an inspection, which showed that the machine was in good condition and it was immediately put back into service.

Secretary Lane in his annual report speaks of the necessity for a new set of mining laws. "The old code," he says, "is so elaborate and complicated that the best of brains can not tell what the law is. The truth seems to be that between mining engineers and mining lawyers the rules of the game have been refined into obscurity; and if Congress were to say to the President that he might select three men familiar with mining laws and miners' difficulties to suggest a new mining code to Congress, it would, I believe, be giving in earnest a new freedom to the mining industry."

The United States produces every mineral that is needed in industry, and this can be said of no other country. We produce 66 per cent. of the world's output of petroleum, 60 per cent. of its copper, 40 per cent. of its coal and iron, and 32 per cent. of its lead and zinc. Tin in small quantities is produced in Alaska and patinum in Oregon, Nevada, and California, manganese in Virginia, Georgia, Arkansas, and California; but of these latter minerals, as of nickel and some others of less importance, our supply is altogether inadequate for our consumption. We can build a battleship, or an automobile (excepting the tires), a railroad or a factory entirely from the products of American mines and forests.—*Annual Report of Secretary of the Interior.*

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 2.

1,158,525. FLUID-PRESSURE MOTOR. EDWARD W. MEREDITH, Reynoldsville, Pa.

1,158,621. FLUID MOTOR, PUMP, AND THE LIKE. CHARLES H. BIRCH, Chicago, Ill.

1,158,679. AIR-SUCTION VALVE. HARRY P. GRAY, Oakland, Cal.

1,158,738. ORGAN-BLOWER. IRA H. SPENCER, West Hartford, Conn.

1,159,094. CENTRIFUGAL AIR-COMPRESSOR. RICHARD H. RICE, Lynn, Mass.

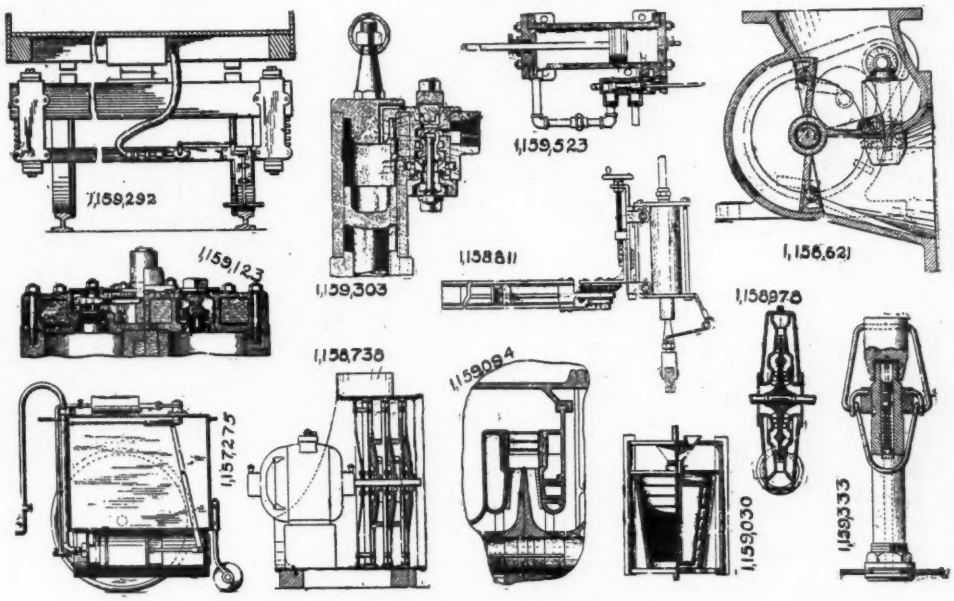
1,159,123. COMPRESSOR. GEORGE F. STEEDMAN, St. Louis, Mo.

1,159,275. DISPENSING DEVICE. ARTHUR M. ROLAND, San Francisco, Cal.

1. A liquid receptacle comprising a tank, a pump connected therewith and supported by the tank below the same, an air tank, a pressure cylinder, a piston therein, pipe connections between the pressure cylinder and air tank to operate the piston, a lever within the tank, and connections between the lever, the pressure cylinder and pump to operate the latter.

1,159,292. EMERGENCY OPERATING DEVICE FOR AIR-BRAKES. JEREMIAH H. TEUTEBERG and PHILIP E. SCHAFER, Baltimore, Md.

1,159,303. FLUID-ACTUATED MOTOR. DANIEL S. WAUGH, Denver, Colo.



PNEUMATIC PATENTS NOVEMBER 2.

1,158,811. STONE-CUTTING TOOL. CHARLES KILBURN, Cincinnati, Ohio.

2. In combination with a standard, of a tool beam pivoted thereon, a tool beam head on said tool beam, a plurality of pneumatic hammers on said tool beam head, means for oscillating said tool beam head as the tool beam is swung on its pivot.

1,158,843. PROCESS OF TREATING RUBBER AND RUBBER-LIKE MATERIALS. RAYMOND B. PRICE, New York, N. Y.

1. The method of treating vulcanizable plastics preparatory to their vulcanization which consists in incorporating a vulcanizing agent therewith and subjecting the mass during or subsequent to the incorporation of said agent, simultaneously to a kneading action and to the action of a vacuum.

1,158,978. TURBINE-PUMP, TURBINE-BLOWER, AND PROPELLER. ALFRED BUCHI, Winterthur, Switzerland.

1,159,030. PNEUMATIC SIFTER. FRANZ HOLL, Worms-on-the-Rhine, Germany.

1. In a device of the character described, the combination of a fan including vanes of varying radius, a separating casing surrounding said fan, and means for feeding material through said casing, substantially as described.

1,159,333. AUTOMATIC VALVE AND HOSE COUPLING AND DUST-CAP FOR PNEUMATIC TIRES. ALFRED BELIVEAU, Providence, R. I.

1,159,335. SEAL FOR VACCUM APPARATUS. FREDERICK G. KEYES, Boston, Mass.

NOVEMBER 9.

1,159,374. PNEUMATICALLY - OPERATED PIANO. CHRISTIAN GULBRANSON, Chicago, Ill.

1,159,406. OILING DEVICE. MIKE MINTZ, Rock Island, Ill.

1. In a device of the class described, the combination with a compressed air chamber, a release valve opening therefrom, a receptacle having its ends partially open, and tubes leading from the extremities of said receptacle to the original oil receptacle.

1,159,434. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,159,518. HYDROPNEUMATIC GAGING APPARATUS. CHRIST MAUL, Chicago, Ill.

1,159,543. FLUID-BRAKE FOR BARREL-RECOIL GUNS. FRIEDRICH STOCK, Essen-on-the Ruhr, Germany, assignor to Fried. Krupp Aktiengesellschaft, Essen-on-the-Ruhr, Germany.

1,159,554. PUMP. CARL J. VELEY and LINCOLN S. DEAL, Kalamazoo, Mich.

1,159,610-1-2-3. FLUID-MOTOR OR PUMP AUGUST SUNDH, Hastings-upon-Hudson, N. Y.

1,159,627. PNEUMATIC - DESPATCH - TUBE SYSTEM. ALEXANDER WATSON, Beachmont, Mass.

1,159,721. MEANS FOR THE CONTROL OF THE FLOW OF AIR IN WATER-TANKS. GEORGE SINCLAIR, St. Paul, Minn.

1. Apparatus of the class set forth, comprising in combination, a receptacle adapted to contain a cooling liquid, means having orifices adapted to project compressed air into said cooling liquid and means for regulating the size of said orifices.

1,159,722. DRILL - SHARPENING APPARATUS. ARTHUR H. SKAER, Denver, Colo.

1,160,076. CENTRIFUGAL AIR OR GAS MOVING OR FORCING APPARATUS. WILLIAM GEORGE HAY, Prestwich, England.

1,160,695. HUMIDIFYING AND HUMIDITY-REGULATING APPARATUS. BRUCE L. CUSHING and EDWARD W. ERRICK, Buffalo, N. Y.

1,160,786. VACUUM - CLEANER. EMIL F. SWANSON, Galesburg, Ill.

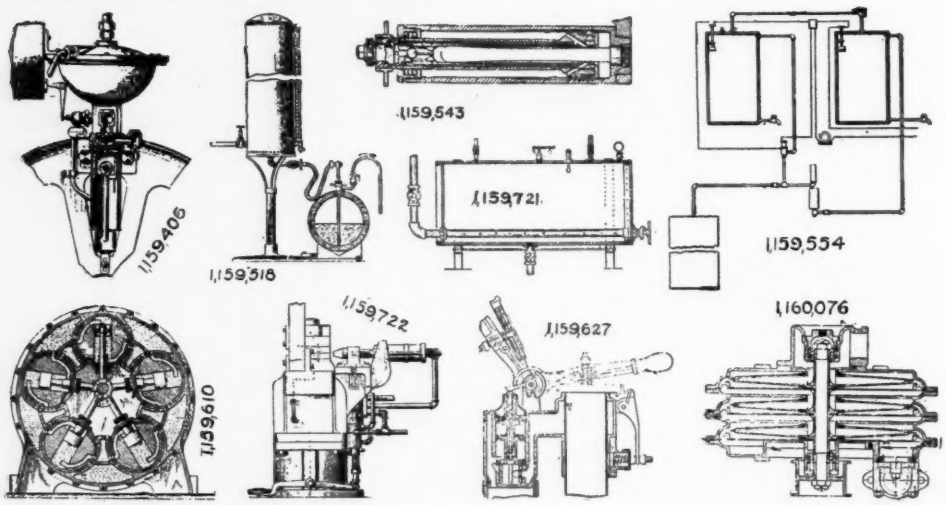
1,160,796. PNEUMATIC SHEET - FEEDING APPARATUS FOR PRINTING-MACHINES AND THE LIKE. FRED WAITE, Otley, near Leeds, England.

1,160,800. ENGINEER'S BRAKE-VALVE. PETER WERTZ, Pittsburgh, Pa.

1,160,801. EMERGENCY AND EQUALIZING VALVE FOR AIR-BRAKE SYSTEMS. PETER WERTZ, Pittsburgh, Pa.

1,160,825. VACUUM STRIPPING APPARATUS. WILLIAM BIRCHALL, Whitworth, near Rochdale, England.

1,160,852. PNEUMATIC SANDER. ANTHONY S. CONTI, Chicago, Ill.



PNEUMATIC PATENTS NOVEMBER 9.

NOVEMBER 16.

1,160,166. AIR PUMP OR COMPRESSOR. HARRY W. HANCOCK, Charlotte, Mich.

1,160,207. VACUUM-PUMP. CHARLES N. SOWDEN, Soledad, Guantanamo, Cuba.

1,160,260. PNEUMATIC ACTION FOR INTERIOR PIANO-PLAYERS. MELVILLE CLARK, Chicago, Ill.

1,160,283. COMMINUTED - FUEL FEEDER. JOHN F. HAY, Erie, Pa.

1,160,321. PNEUMATIC SPRING FOR VEHICLES. WALTER L. RICE, Denver, Colo.

1,160,411. PRESSURE-PUMP. RUSSELL HUFF, Detroit, Mich.

1,160,426. ALTITUDE - GAGE. COLEMAN J. MANNING, Medford, Mass.

1,160,528. AIR OR OTHER FLUID-PRESSURE PUMP. WILLIAM RENARD PILKINGTON, Bamber Bridge, near Preston, England.

1,160,562. GOVERNING MECHANISM FOR CENTRIFUGAL BLOWING-ENGINES. OTTO BANNER, Easton, Pa.

1,160,578. PNEUMATIC TOOL. JOHN F. CLEMENT, Philadelphia, Pa.

1,160,617. HANDLE AND INLET-CONTROLLING-VALVE CONSTRUCTION FOR PNEUMATIC TOOLS. FRANCIS A. JIMERSON, Athens, Pa.

1,160,922. CHANGE-SPEED MECHANISM FOR MOTOR-VEHICLES AND THE LIKE. JOHN G. MACPHERSON, Philadelphia, Pa.

NOVEMBER 23.

1,161,102. PNEUMATIC SHOCK-ABSORBER. WILLIAM G. WOOD, Sacramento, Cal.

1,161,128. COMBINED ENGINE AND COMPRESSOR. HERBERT T. HERR, Denver, Colo.

1,161,219. PROCESS OF AERATING WATER IN MAKING ICE. WILLIS B. KIRKPATRICK, Baltimore, Md.

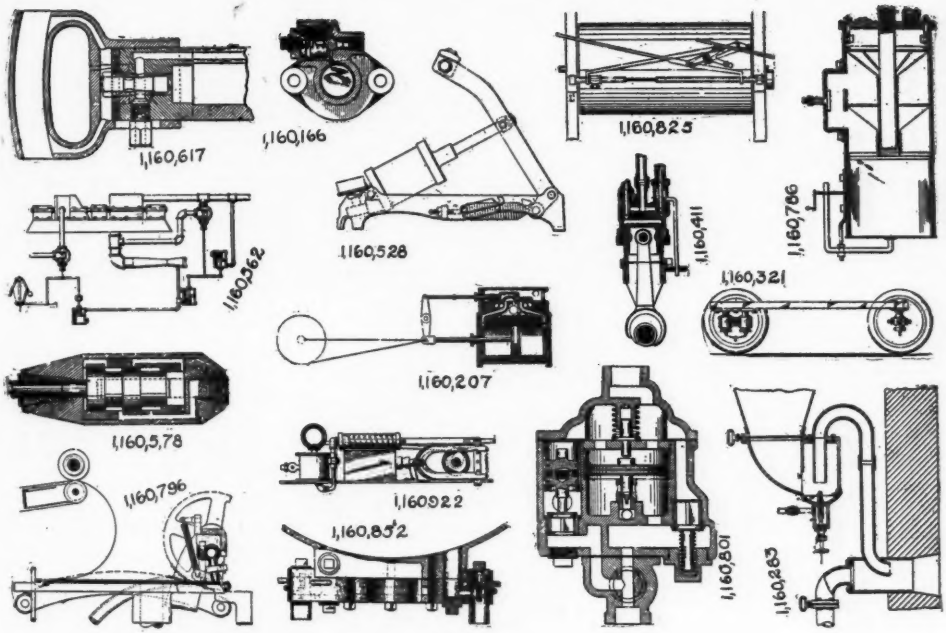
1. A process of agitating water by air in making ice which consists in compressing the air to a pressure in the vicinity of from twelve to twenty-five pounds above atmosphere, dehydrating the air by cooling it, reducing the pressure, passing such air through the mass of water to be frozen following a path near the center, and delivering air into the mass of water at the bottom.

1,161,259. DRILLING MACHINE. MATHER W. SHERWOOD, Franklin, Pa.

1,161,263. CLEANING APPARATUS. IRA H. SPENCER, West Hartford, Conn.

1,161,350. AIR-PURIFIER AND TEMPERATURE-REGULATOR. GEORGE SINCLAIR, St. Paul, Minn.

1. In an air purifier and temperature regulator, an air tank adapted to receive air under

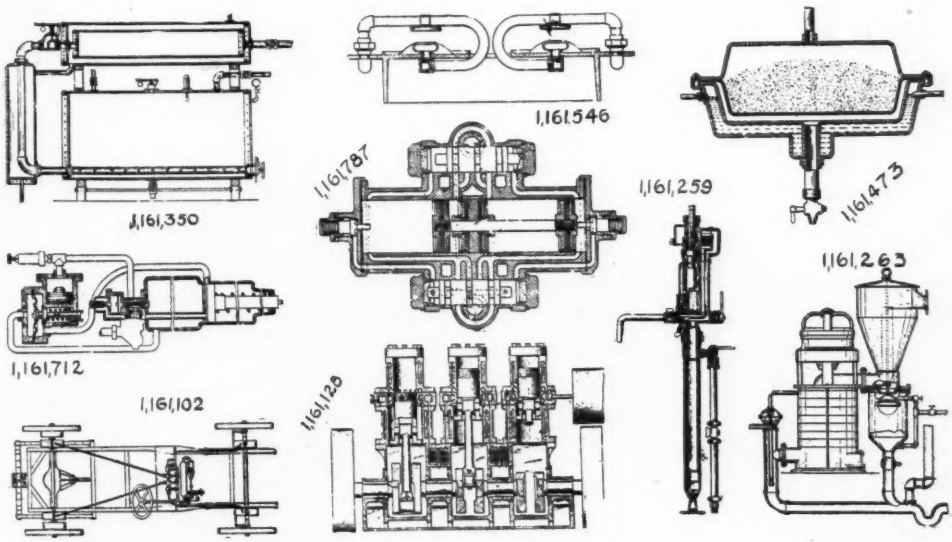


PNEUMATIC PATENTS NOVEMBER 16.

pressure, means for cooling compressed air in said tank, a water tank communicating therewith, a perforated pipe extending across the bottom of said water tank, a valve for automatically releasing the air in said compressing tank at a reduced pressure through said perforated pipe and into the water in said water tank to purify the same.

1,161,473. METHOD OF DRYING AND ENRICHING PHOSPHATE MATERIAL AND THE LIKE. MAXIMILIAN MATTHEUS HAFF and THOMAS LEOPOLD WILLSON, Ottawa, Ontario, Canada.

3. The herein described method of drying and enriching a phosphate material which comprises placing the material in a closed container and



PNEUMATIC PATENTS NOVEMBER 23.

introducing ammonia gas and air under pressure.

1,161,546. HYDROCARBON-BURNER. James W. Stirton, Detroit, Mich.

1,161,712. AUTOMATIC RETAINING-VALVE FOR AIR-BRAKE SYSTEMS. Ernest U. Mack, Florence, S. C.

1,161,787. COMBINED MOTOR AND PUMP. Frederick C. Nickol, Dayton, Ohio.

1,161,789. CEMENT OR MORTAR MIXER AND ELEVATOR. Frank Orth, Indiana Harbor, Ind.

1. In a device of the class described, the combination of a conveying and mixing pipe, means for introducing dry materials into the front end of said pipe in desired proportions, means for creating a current of air throughout the length of the pipe for the purpose of carrying the dry materials along the pipe and mixing them together, means for heating said materials after they are mixed together and before they leave the pipe, and means for introducing water into the pipe and into contact with the materials after they are heated, substantially as described.

NOVEMBER 30.

1,161,907. POWER-HAMMER. Lewis E. Summers, Detroit, Mich.

1,161,917. FLUID-PRESSURE-REGULATING VALVE. Charles L. Bastian, Chicago, Ill.

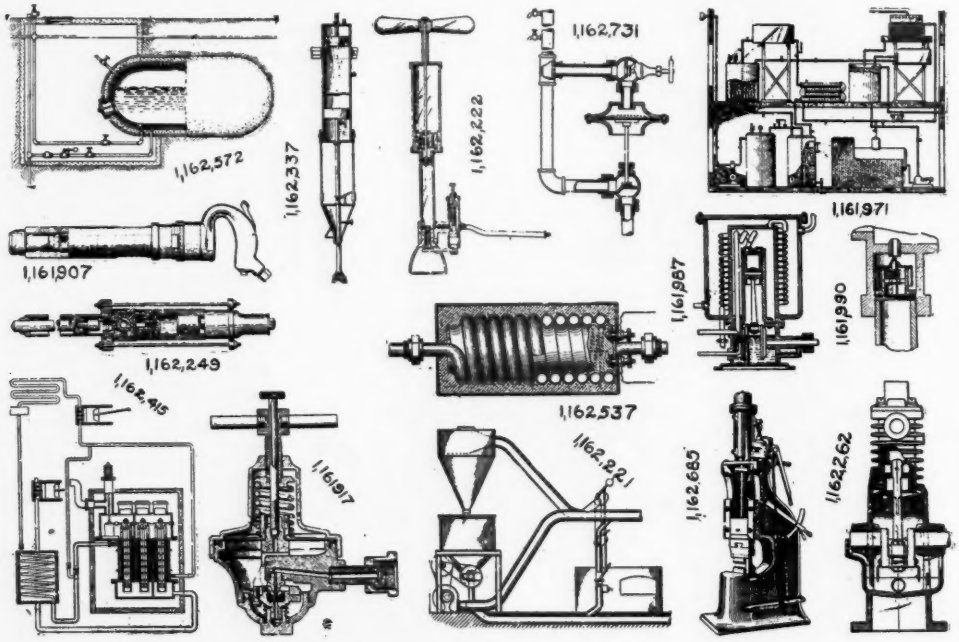
1,161,937. REFRIGERATING APPARATUS. Ludwig Horst, Hamburg, Germany.

1. In a refrigerating apparatus, the combination with the compressor, of a receptacle providing a condensing and a cooling chamber of large cross-sectional area, said condensing chamber communicating with the outlet from the compressor, means to direct a cooling medium through said cooling chamber, and an externally cooled condensing coil communicating with the condensing chamber.

1,161,971. APPARATUS FOR PURIFYING AND AERATING WATER. Joe F. Quigley, Oklahoma, Okla.

An apparatus for purifying and aerating water, including a boiler, a condenser, a steam pipe leading from the boiler to the condenser, a closed storage tank receiving the distilled water from the condenser, a compressed air tank, a washer receiving the air from the tank, an air cooling chest, a pipe leading from the washer to the air cooling chest, a heating coil surrounding a portion of the said pipe between the washer and cooling chest, a steam pipe establishing communication between the heating coil and the boiler, means for leading the air from the cooling chest to the storage tank and causing it to bubble upwardly through the water therein, and a check valve applied to the storage tank for permitting the escape of the air when an excessive pressure is reached.

1,161,990. COMBINED FLUID-PRESSURE REGULATOR AND SAFETY VALVE. Arther L. Smyly, Chicago, Ill.



Pneumatic Patents November 30.

1,162,221. POWDERED-FUEL FEEDER. Walter L. Caven, Cincinnati, Ohio.

1,162,222. AIR-PUMP. Leroy Clawson, Hall, Mont.

1,162,249. ROCK-DRILL. Vincent John O'Brien, Denver, Colo.

1,162,262. LUBRICATING APPARATUS FOR COMPRESSORS AND SIMILAR MACHINES. George F. Steedman, St. Louis, Mo.

1,162,337. GLASS-BLOWING MACHINE. Earl G. Chase, Smethport, Pa.

1,162,415. PROCESS OF AND APPARATUS FOR PRODUCING OZONE. Jan Steynis, Bay Shore, N. Y.

1,162,537. COMPRESSED-GAS HEATER. John Joseph Yager, Sheridian, Wyo.

1,162,572. COMPRESSED-AIR CISTERN. Wilbur T. Clark, Ashtabula, Ohio.

1,162,685. STONE-BREAKING MACHINE. Henry E. Derbyshire, Chambersburg, Pa.

1,162,731. VACUUM REDUCING-VALVE. William P. Burke, Springfield, Mass.